THE DIALECTICAL ENVIRONMENT OF THE MIND: A PHILOSOPHICAL FOUNDATION FOR BIOMIMICRY IN THE THEORIES OF G.W.F.HEGEL AND JEAN PIAGET

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ABSTRACT

Biomimicry is a technological approach to engaging with the natural world which looks to nature as an intellectual source to solve human problems. The current problems of environmental degradation and the challenges of long-term sustainable production have given rise to the practice of biomimicry. This new form of technologically engaging with the world is reflective of a certain relationship between self and object. This new relationship of subject and object, or the cognitive and natural, is, I argue, best understood dialectically. In making this argument, I first reconstruct the work of G.W.F Hegel and Jean Piaget. I begin with Hegel and his theory of cognitive development, which leads directly into his philosophy of nature. Next, I present Piaget's theory of mental development as it plays itself out in the field of psychology and then in biology. Finally, I defend the methodological principles and critique of so-called instrumental rationality or means-ends rationality in subsequent Hegelian critical theory. My project is to provide a philosophical foundation for the technology of biomimicry and show how we can understand the significance of biomimicry through a reconstruction of Hegel's philosophy of nature. This is because there already is contained in his theory a critique of positivism (the Understanding), which will later be called instrumental reason by the Frankfurt school tradition. Indeed, one could even see biomimicry as an advanced stage in Hegel's understanding of the rational development of nature, and our dialectical relationship to it.

The form and content of this abstract are approved. I recommend its publication.

Approved: Myra Bookman

DEDICATION

To Bonne, for giving me two of the greatest gifts possible: life and the love of reading. To Lex—warrior poet—for keeping me going and suffering with me. To my partner Vanessa, for endless love, endless understanding, and for endlessly pushing me to become better.

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METHODOLOGY STATEMENT

To frame my research, I intend to work within the Critical Social Sciences, or Critical Theory tradition. In line with Critical Theory, I maintain that the proper task of thinking is epistemological analysis that questions into the ontological. As Guba and Lincoln suggest in their article "Competing Paradigms in Qualitative Research," methodological questions arise from epistemological questions, which are in turn the result of ontological questions.[1] W. Lawrence Neuman also makes a similar claim in *Social Research Methods*: "Epistemology is the issue of how we know the world around us or what makes a claim about it true. How we learn about or know the world is rooted in our ontological assumptions."[2] The *answers* that one gives to ontological questions will determine the *answers* that one provides to epistemological questions, which will in turn ossify one's methodology; or at the very least, influence (and limit in some cases) one's methodological approach to questions. One's method and mode of inquiry is determined and directed to a large extent by one's ontological and epistemological assumptions.

This suggests that method will result from inquiry, which may appear to be a circular claim. This is not so if we simply exchange the term *answers* for *assumptions* in the earlier statement. Exchanging these terms not only shows the veracity of my prior claim concerning the proper task of thinking, but also supports one of the main claims of the Critical Social Sciences: Knowledge cannot be separated from the human situation (values, historical situations, environmental factors, cultural influences, etc.). When theorists in this tradition state that inquiry is determined beforehand they mean precisely that the human situation, complete with its

[1] Guba & Lincoln, "Competing Paradigms in Qualitative Research," 108.
[2] Neuman, "The Meanings of Methodology," 93.

inescapable pre-established ontological and epistemological frameworks, directs the questioning. Habermas argues this exact point in his essay on the subject, suggesting that human interests can never be separated from the knowledge produced alongside it.[3]

To inquire into method is to inquire into epistemological assumptions, and to do that is in turn to question the most basic ontological claims of knowledge humans can provide. Like Critical Theory, this assumption is also shared by Phenomenology. Both traditions, emerging from Hegel, make one very basic assumption that any researcher who plans to work within either tradition must come to terms with: "The investigator and the investigated object are assumed to be interactively linked."[4] In other words, there is an interaction, synergy, or dynamism between the ontological and epistemological.

Neuman states, quite correctly, the major assumptions that the Critical Theory tradition asserts:

> Critical Social Science states that our experiences of empirical reality are always theory or concept dependent. Our theories and concepts, both commonsense and scientific, sensitize us to particular aspects of empirical reality, inform what we recognize as being relevant in it, and influence how we categorize and divide its features. Over time, new theoretical insights and concepts enable us to recognize more aspects in the surface, empirical reality and to improve our understandings of the deeper levels of reality..." therefore, "…our ability to understand reality [is] an interactive process in which thoughts, experiences, and actions interact with one another over time.[5]

It is within and out of this tradition that my research is grounded. I will examine how concept formation occurs, as well as the current concept humans maintain of the natural world itself. The former is my epistemological investigation, and the latter is my ontological. Also in accordance

[3] Habermas, *Knowledge and Human Interests*.
[4] Guba & Lincoln, "Competing Paradigms in Qualitative Research," 110.
[5] Neuman, "The Meanings of Methodology," 110. Brackets mine.

with Critical Theory, my project is a theoretical exercise with practical applications, rather than an investigation into practical situations directed by a specific theory.

Critical Theory allows for an appropriate amount of contextual influence while also maintaining the capacity to have a relationship to truth so as not to slip into (a post-modern like) relativism. Furthermore, my presentation will take the form of an "explanatory critique."[6] After examining prior theories within the tradition and their appropriateness to our current historical, social, and environmental situation, I intend to offer a critical moment that seeks a change in both our actions and way of thinking; specifically in regards to the human environmental relationship. This will, therefore, require a textual analysis of some of the main works of Critical Theory that address this situation.

Demonstrating how our theories apply to our practices, as well as showing that both our theories and practices are capable of being altered (specifically in relation to one another), is an implicit claim of my explanatory critique. While I will at times focus on specific practices, my overall intention is to question the basic conceptual formations which determine these practices. I suggest that by doing so, we can effectively comprehend and change human practices. Not only is the issue of questioning the theoretical foundations for our practices and actions of central importance to the overall project of advancing human knowledge, but it is especially important for dealing with such practical issues such as resource management, environmental degradation, emancipation, and the possibility of sustainability.

[6] Neuman, "The Meanings of Methodology," 112.

INTRODUCTION

We are the parents of a Nature of which we are also the children. It is in human being that things become conscious of themselves; but the relationship is reciprocal: human being is also the becoming-conscious of things. Nature leads, by a series of disequilibria, toward the realization of human being, which in turn becomes the dialectical term of it.[7]

Biomimicry is a radically new technological concept that not only reexamines our relationship to nature, but also acts in a partnership with it. The guiding premise underlying its development is that nature can be seen as more than just a resource available for material exploitation. Rather, nature offers conceptual resources for design, production, and closed loop sustainable system building. Biomimicry is a way of recreating the processes and designs of nature through human technology so we are working with rather than against the natural world. This new development in technology and natural science goes directly against centuries of scientific thinking about nature and technology. I want to contrast this new relationship to nature with the traditional view of the natural world, as well as demonstrate how there is a long philosophical tradition within which we can best understand this new development. The purpose of this thesis is thus to contextualize this new technology, provide a philosophical foundation for it, and to show its relationship to an established tradition of natural philosophy.

Examining the relationship human beings have toward the natural world will lead to the understanding of how our praxis, most clearly seen through our technologies, is determined by our self-understanding. This self understanding is in turn dependent on, and developed from, the relationship between human cognitive development and the natural environment. In other words, our relationship to nature, our actions and technologies, as well as our self-understanding are in a dialectical relationship with one another. It is taken to be the case that our theories, through praxis, correspond and direct our actions in the world as well as our technologies. Technological

[7] Merleau-Ponty, *Nature: Course Notes*, 43.

development is the specific component of praxis that I intend to examine. Biomimicry then, just like the technologies antecedent to it, expresses a specific understanding of human beings and the environment.

The dominant view of nature as a base resource for human exploitation emerges in its most clear expression in modern science. I would like to examine this view of nature and show how the methods of technological development that have emerged from it are inherently contradictory to natural systems and their method of development. On one hand there is an empirical contradiction that expresses itself in the destruction of ecological systems and the incompatibility of certain forms of human technology. The clearest example of this contradiction is the environmental damage that results directly from the interaction of human technology with ecological systems. The empirical data coming from this form of technology's interaction with the natural world shows the incompatibility of it with any closed loop natural system. A closed loop system internalizes all waste and externalities within the system. All processes serve the continual functioning of the system, making it self sufficient. Biomimicry attempts to replicate such systems and natural forms thereby formulating a more organic technology that is compatible with natural systems. Naturally compatible means the ability to exist alongside, and feed into, ecological systems efficiently without disrupting or damaging these systems. This revolutionary technological and empirical insight is a response to a contradiction in the human understanding of nature.

There is expressed alongside this empirical contradiction a similar contradiction in rationality. This contradiction results from instrumental rationality becoming the dominating form of thinking about and relating to the environment. This latter contradiction was taken up and expanded on by the critical theorists of the Frankfurt School. While the Frankfurt School

may have elaborated most expressly this critique of rationality, the critique itself goes back much further. I intend to show that the source of this critique is the dialectical thought of G.W.F. Hegel, and by extension Jean Piaget. Both Hegel and Piaget advance a general knowledge of how human beings, as subjects in an environment, learn and comprehend both themselves and their environment. My close examination of these theories will elucidate the conceptual groundwork from which biomimicry was allowed to develop. Showing how a dialectical concept of nature has altered human practices, and specifically technology, will be central to understanding the reason for the development of biomimicry.

First, I define biomimicry. I provide numerous examples of this technology, and show how it relates to nature in a different way than those technologies based on instrumental rationality. Next I shift the discussion to philosophy of technology, and demonstrate how technology since the modern period is based on instrumental rationality. Biomimicry, I suggest, challenges the established understanding of nature. As our relationship toward nature and our understanding of it changes, so too will our technologies. These new technologies then express the new relationship and understanding. Once created, these new technologies open themselves up to reflection, effectively beginning the process over again. This dialectical interplay between our understanding of nature, our technologies, and our relationship to it, I claim, has a history in philosophy. I maintain that there is a philosophical basis for the emergence of this new technology. Furthermore, that this new technological development is best understood through the theories of Hegel and Piaget. Their theories explain the recent shift in contemporary thought regarding nature, ecology, and sustainability. Examining Hegel and Piaget's theory of dialectical development will help us to understand not only our own process of mental development, but that of the development of nature as well. Furthermore, it will also frame the emergence of

biomimicry in a logical system. This will effectively show its logically necessary development as an attempt to unify the human/nature separation.

Therefore, my second section will begin with the philosophical thought of Hegel. One insight that Hegel provides is the understanding that our conceptions of self, nature, knowledge, etc. are poor or lacking to the extent that they lead to contradictions. In Hegel's view, contradictions open up the possibilities of their own eventual resolution. After reconstructing this notion of dialectical development I move to Hegel's application of this understanding to the development of consciousness. This is important to my overall argument because it shows not only how human beings develop within an environment, but also posits an understanding of the mind and substance as one. In other words, Hegel's theory identifies a way in which the subject/object or mind/world division can be reconciled. My third section examines Hegel's *Philosophy of Nature*. In this text, Hegel argues that the development of nature is not only the rational unfolding of what he calls spirit (Geist), but argues that this development is, like the development of consciousness, dialectical as well. His account of nature is a conceptually based a priori account of natural development. This is a specific reading of Hegel's *Philosophy of* Nature. More will be said about what this account entails later in this section.

My fourth section looks at the "crisis of the sciences" that emerged after Hegel and which is illuminated by Edmund Husserl. We can see here the early stages of the contradiction of instrumental rationality as it is applied to the newly developed science of the mind: Psychology. This crisis led to new developments in psychology, one of which is Piaget's developmental theory. The importance in comparing these theorists is twofold. First, it is important to see how Hegel's theory of dialectical development progressed in Piaget's work and second, what a dialectical method looks like in empirical studies. Hegel's theory, while referencing empirical

and historical facts, was never experimentally applied. Piaget, on the other hand, was an ardent empiricist. His theory was derived from the facts as they were presented to him throughout his empirical studies. He references both his own findings, as well as the findings of other thinkers of his day. By examining this data, Piaget formulates a dialectical theory of psychological development. I see Piaget's findings as an empirical study in support of Hegel's theory of dialectical development.

The advance of the sciences in the one hundred and fifty years between the thinkers is dramatic. Piaget not only adds necessary empirical arguments for a dialectical account of development, but was also privy to many scientific discoveries that Hegel was not. I see Piaget's work as an extension and fuller elaboration of Hegel's project in accordance with empirical data. Hegel saw all of knowledge as a complete circle. Piaget, working after the specialization of knowledge occurred in the modern period resulting in distinct fields of research, seeks to erase the divisions between fields of knowledge, and to promote a "circle of the sciences." He sees all knowledge as interconnected. This leads Piaget to see the division of the sciences as artificial. After examining Piaget's theory of mental development, I move on to his theory of biological development. Piaget's account of natural development is based on his account of cognitive development. Like his theory of mental development, his theory of nature is based on the dialectical functioning of systems. In other words, it is an empirically based account of nature as dialectically unfolding. One important dimension to emerge from this explication is how both Hegel and Piaget construct their psychological theories beginning from the basic desires or needs of the subject. This needs based starting point shows the fluidity of their theories of mental development with biological development. Therefore, both thinkers can be thought of as environmental thinkers, who elaborate need-based systems of development, out of which human

behaviors and relationships emerge and, when necessary, alter. As both Hegel and Piaget argue, the proper concept of both human and natural development is that of dialectic. Such dialectical development is dependent on the interrelationships between the human mental subject, its physical body, the social environment, and the physical environment. In light of this, there will be two important aspects that I will not be able to specifically address. The first is the role of the physical body of the subject and the second is the subject's relationship with the social environment. Both relationships are important to the development of consciousness, but due to length I will only be able to reference them in passing. I focus primarily on the role of the natural environment in cognitive development.

My fifth section examines the critique of instrumental rationality. The Frankfurt School is credited with reevaluating the current form of reason through which we comprehend reality. They suggest that the crisis we are experiencing empirically (through environmental degradation and resource limitation) relates to a crisis of human rationality. Specifically, this crisis is the result of instrumental reason coming to dominate the human relationship to nature. I begin by looking at the theoretical influences of Frankfurt School. These influences include primarily Hegel, Marx, and Freud. Next I outline what is meant by critical theory, and how it is contrasted with traditional theory. At this point, I will work through the critique of instrumental rationality as it is presented in the *Dialectic of Enlightenment* by Horkheimer and Adorno. This text analyzes the instrumental rationality of enlightenment thinking and makes explicit the contradictions that have emerged from it. This critique was a direct response to what they saw as the disaster of enlightenment instrumental reason in the early twentieth century, resulting in fascism. In this text they claim that a particular form of rationality has come to permeate all thinking, and thereby human relations: i.e. instrumental reason. This form of rationality is a form

of domination that comes to be expressed both between human beings and over the natural world. It comes to define our self-relation and self-understanding. It does this by reducing all of nature to base matter of entities which science can then calculate. Subsequent Frankfurt School theorists have accepted this critique, at least in part. They have also attempted to provide non-instrumental accounts of reason, as with, for example, Habermas through his theory of communicative rationality.[8] Their work exists as a starting point for the elaboration of a new emancipatory relationship toward nature and self-knowledge. It provides a critical moment from which to question the dominating form of instrumental reason. They argue that there is a different concept of rationality that is more appropriate and successful in bringing about a new understanding of self and nature. Dialectical rationality offers the counter position to instrumental reason, and is capable of helping us understand, critique, and supplant the dominant Western relationship to nature and technology, which has now become the global position toward nature.

Finally I conclude that human practices and technologies *are* in fact altering as a result of the contradiction in the human concept of nature. I suggest that the emerging technology of biomimicry is a salient example of such a shift. Recognizing development in a dialectical way provides new insights into our contemporary technologies. The theoretical impact of these systems will allow for a more complete understanding of human practices as they relate to the natural environment. As the emergence of biomimetic technology demonstrates, we are now becoming aware of the critical insights and truths of a dialectical understanding of cognitive and natural systems, or so I will argue. This is achieved as a result of the systematic contradictions emerging between the human knowledge of the world, behaviors that result from this knowledge,

[8] Vogel, *Against Nature*. See the final chapter, "Toward a Communitive Theory of Nature," for Vogel's application of Habermas' theory of communicative action to environmental ethics.

and from the reactions of the environmental system to these behaviors. Whether it is through the technological innovations of biomimicry and the challenge that it provokes to the traditional conception of nature, or through the abstract understanding that the form of reason through which we have come to relate to the natural world is intrinsically flawed, the logic at work in the human/nature relationship will unceasingly express itself until it is reconciled.

My project was motivated by my initial inquiry into various theoretical concepts of self and the extent to which they were convincing. In my investigation I became interested in the constitutive interrelationship that exists between the self and the natural environment discussed in the works of Piaget, Merleau-Ponty, and Hegel. In particular, I became interested in how changes in our conceptual understanding of self/nature are capable of altering our practices and actions in the world. Also when evaluating these shifts in human praxis, I wanted to understand not only why they were occurring, but more importantly what they mean for the human/nature relationship. This became increasingly important for my work as I continually saw how this relationship—both conceptually and practically—led to human self-knowledge and understanding.

At a conference in Vancouver where I was speaking on the relationship of Piaget's thought, particularly on the disequilibria of cognitive structures to the external environment, I attended a lecture on bioengineering. The idea of altering natural systems for the benefit, or rather the convenience, of humanity struck me at first as hubristic. However, slowly the logic of it dawned on me. First, this is the call of Spirit as demonstrated by Hegel: That the external world should be altered to reflect the mind, allowing it to come closer to knowing itself. Secondly, human beings have been participating in bioengineering for centuries now. It is only at this point that we have enough awareness to take the reins of control. The thought was

overwhelming until I saw several TED talks on biomimicry. It was at this point that I came to see that taking the reins, so to speak, did not require taking a dominating position. Rather, if done properly, this ascension has the possibility of cultivating an urgently needed mode of sustainable co-existence between the human and nature.

CHAPTER 1

BIOMIMICRY

Science thinks nature, philosophy comprehends it…[9]

In this chapter I discuss the nascent technology of biomimicry. I argue that by closely examining this technology we can gain valuable insights into our philosophical understanding of both ourselves and nature. In the first section I begin by discussing what biomimicry is and what it is not. I suggest that this technology is not as new as some claim but rather has its origins alongside human claims to knowledge. In other words, I suggest that it maintains a historical partnership with human knowledge. The issue, I argue, is that this form of technology, and the understanding of the world that it is based on, is both overlooked and pushed aside by modern science and so called instrumental rationality. I will also provide contemporary examples of biomimicry. I place specific emphasis on the distinction between technologies which are instrumentally based and those of biomimicry. Biomimetic technology, I claim, is dialectically based, and works within the closed loop systems of nature.

In the second section I examine the philosophical foundations for this emerging practice. I begin by looking at its very recent history. Next, I contrast it with the more dominant approach to science and technological development which relies on instrumental rationality and is ends directed. I define instrumental rationality, and show how this form of thought has become the dominant understanding of nature and technology. This method of relating to nature and technology is the modus operandi of the modern period.

In the final section of this chapter I look at look at the role technology plays in human experience though various philosophies of technology. What I intend to show is that technology

[9] Alexander, "Hegel's Conception of Nature," 496.

is a mediating practice serving to relate human mind to the natural world, and a means of attaining higher forms of knowledge.

The Emergence of Biomimicry: Technologies of Nature

Biomimicry is the imitation of the processes of the natural world for the problem solving benefit of the human species. It is the observation and replication of the ways in which obstacles are overcome in nature by nature itself. Biomimicry is the conceptual term for the technology and knowledge produced from human begins learning to create and solve problems from the natural world. It is the imitation of systems, designs, and processes of production found in natural systems for human systems. It is an approach to development that looks to nature as both a source of inspiration and as a template for sustainable human development. It is the integration of human technological systems with natural systems.

Human learning involves looking at how problems are solved in the world by others. In the case of biomimicry the "other" is the multifarious forms of life of the natural world. The technology of biomimicry has its roots in the earliest tool-making inventions of human beings. Inventions such as the first curved serrated knife to the ornithopter of Leonardo DaVinci, and by extension our modern day aircraft, both of which are based on mimicking the flight of birds, all looked to the natural world to solve human problems.[10] I argue that this method of technological development was in use historically, alongside, or in conjunction with and instrumental rationality. However, emerging from the successes of natural science and industrialized practices, the latter form of design and production began to dominate. This is the industrial method of production dubbed by biomimicrists as the "heat, beat, and treat" method.[11] The

[10] Priesnitz, "Biomimicry," 16.
[11] Thomas, "Biomimicry: Nature's Engineering Principles," 31. See also: Benyus, *Biomimicry*, 101.

control, predictability, and reliability of this approach allowed for it to become the dominant method of technological development and relating to nature. In recent years, the pendulum has begun to swing back to looking at natural systems.

The major reason for the popularity of biomimicry is its interdisciplinary approach to problem solving. It draws on numerous specialized fields and combines their innovations in unique ways.[12] Since the main premise of biomimicry is looking to the natural world to influence and inspire human technologies, it only makes sense that biomimicrists also look to each other in different fields of research as well. The following are some contemporary examples of interest. Many of the biomimetic developments that have occurred in our times are in response to—and directly work to remediate—anthropomorphic environmental degradation.

The Stenocara or African Namib desert beetle has a uniquely bumpy exoskeleton that is capable of collecting droplets of water from the air. Technologies have been developed based on its design for water collection devices.[13] This technology will become useful for arid areas of the world (and also for the expected desertification associated with climate change). Various species of fungi are capable of breaking down everything from petroleum, plastics (specifically polyurethane), iron, and volatile organic compounds for their use as food and energy sources. Coupled with their ability to live in low light/low oxygen conditions, they are ideal for use in bioremediation. Their processes are also being mimicked and replicated on an industrial level.[14] These fungal species appear to be nature's response to the "problem of the biodegration of synthetic plastics." Similarly, various forms of bacteria have been used for many years not only

[12] Benyus, *Biomimicry*, 110. Benyus, in her essential text on the subject, called interdisciplinarity the "future of biomimicry."
[13] Harris, "Biomimicry to Help Capture Water From Air?" 153. See also: Thomas, "Biomimicry: Nature's Engineering Principles," 32.
[14] See: Attenborough, *The Private Life of Plants*, 41; digitaljournal.com/article/320986; Qi, et al., "Biodegradation of volatile organic compounds by five fungal species."

for bioremediation, but also to enhance mining techniques. Along with bacteria, forms of fungi and yeast have also been used for the bioremediation of oil spills and the successful breakdown of hydrocarbons.[15] Velcro "was created in the image of seed hooks that fasten into objects when they brush up against them."[16] This is perhaps the simplest and most recognized example of the mimicking of a natural phenomenon. The development of non-toxic organic waterproof paper is mimicked from the nest making practices of the paper wasp.[17] The membranes of the mangrove have led to new water desalination applications.[18] The idea surrounding the mangrove's water purification processes was presented in 1982 by Helmut Tributsch. It has been elaborated and developed by John Todd and is now being applied in conjunction with other biomimetic techniques including the use of algae, bacteria, and various species of fish for large scale water treatment facilities and bioremediation projects.[19] Advancements in photovoltaic application, ultraviolet reflection, sunscreen, and fire-resistant technologies have emerged from mimicking aspects of various species of aloe vera.[20] The Japanese Shinkansen Bullet Train was structurally modeled after the Kingfisher's beak.[21] The Eastgate Centre Building in Zimbabwe was modeled after the passive cooling thermal control structure of termite mounds. As a result, the structure does not require a heating or cooling system.[22] Superhydrophobicity in metals and plastics mimics the structural surface of a lotus leaf. This technology uses small nano-grooves on the

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[15] Yemashova, et al., "Biodegradation of Crude Oil." See also: Vogel, *Comparative Biomechanics*, 424.
[16] Reed, "Resources in Technology A Paradigm Shift," 23.
[17] Kudo, et al., "Physiological Ecology of Nest Construction."
[18] Tributsch, *How Life Learned to Live*, 184.
[19] Todd, "Ecological Engineering for Waste Water," 173. See also: toddecological.com/eco-machines/
[20] Attenborough, *The Private Life of Plants*, 94. See also: Bond, "Dead Leaves and Fire Survival."
[21] asknature.org/product/6273d963ef015b98f641fc2b67992a5e
[22] asknature.org/product/373ec79cd6dba791bc00ed32203706a1

surface material to allow gas to rest under water droplets, thereby making the water form beads that roll off rather than spread out. This technology has revolutionized de-icing techniques.[23] Advancements in self-healing or bendable concrete have been developed by looking at the self-healing capacities in animals and trees.[24] This technology will become particularly useful in the development of earthquake resistant building materials. The production of "dermite denticles" on the surfaces of materials mimics the surface of shark skin. This technology has led to many benefits including advances in the surfaces of healthcare equipment to prevent disease from germ transmission, advances in sea and air craft technology, as well as swimwear.[25] Michael Phelps gold metals may in fact be partially attributed to this technology. Gecko tape is a material that mimics the nanoscopic hairs of the gecko allowing it to attach to any surface including glass.[26] The 2008 Nobel Prize in Chemistry was given to Doctors Shimomura, Chalfie, and Tsien for the "discovery and development of green florescent protein." Green florescent protein is used to attach to other proteins, thereby allowing scientists to map their biological functions.[27] This brief list reflects only some of the better-known examples of biomimicry.

Complete in Itself: Toward a Philosophical Foundation for Biomimicry

Having defined biomimicry and provided examples of its application, I would now like to question as to what are the ontological/epistemological reasons for its emergence. Biomimetics came on the technological scene in the 1960's as a component of a radically new fringe science

[23] See: Barthlott & Neinhuis, "Purity of the Sacred Lotus."; Barthlott & Neinhuis, "Characterization and Distribution."; Eadie & Ghosh, "Biomimicry in Textiles."
[24] Li et al, "Robust Self-Healing Concrete," 215-216. See also: Mihashi & Nishiwaki, "Development of Engineered Self-Healing and Self-Repairing Concrete," 271-272.
[25] Thomas, "Biomimicry: Nature's Engineering Principles," 34. See also: biomimicryinstitute.org/home-page-content/home-page-content/biomimicking-sharks.html and ocean.si.edu/ocean-photos/biomimicry-shark-denticles
[26] Autumn et al, "Evidence for van der Waals Adhesion in Gecko Satae."
[27] nobelprize.org/nobel_prizes/chemistry/laureates/2008/

biotechnology. In its early nascent form, it had little to do with design. It focused almost exclusively on the replication of chemical processes in natural systems.[28] Ten years later, a new approach to agricultural techniques was being formulated. The permaculture movement had begun, and its basic principles elaborated in 1976.[29] It was in the 1990's, with the push of environmentalism and a new focus on issues of ecology, that biomimicry gained momentum. M. S. Dahir, in a short introduction to the research being done in biomimicry in 1991, makes an appeal for the need for further research and experimentation.[30] In 1993, the term and concept was popularized in Time magazine and introduced to the public. From that point forward the flood gates have been opened. John Todd and Nancy Jack Todd presented the "Todds' Principles of Ecological Design," in 1994. Ecological design became the precursor to biomimicry, which would later incorporate all forms of innovation that mimics the natural world including biotechnology and permaculture. In 1997, Janine Benyus published *Biomimicry: Innovation Inspired by Nature*, which set out the "principles of biomimicry."[31] In 2006, the Biomimicry Institute was established as a non-profit organization to advance, educate, and maintain a data base of biomimetic innovations in science, design, and production.[32]

The question I would like to look at is why biomimicry, and why now? More importantly, why did biomimicry feel the need to distinguish itself from more traditional forms of design, production, and integration technologies? There are two factors which have given rise to biomimicry. The first is the physical results of more traditional, non-integrative, technologies.

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[28] ApSimon, "The Total Synthesis of Natural Products," vii. "Throughout the history of organic chemistry we find that the study of natural products has provided the impetus for great advances."
[29] Edwards, *The Sustainability Revolution*, 120, 124.
[30] Dahir, "Imitations of Life," 19.
[31] Benyus, *Biomimicry*, 13. See also: Edwards, *The Sustainability Revolution*, 124.
[32] www.biomimicryinstitute.org/about-us/

As environmental damage became more prevalent, technologies were beginning to be judged by their harmfulness to natural systems, rather than solely by their relevance and productiveness for society. The second factor for the emergence of biomimicry was a contradiction in the human understanding of the natural world. Instrumental rationality treats the natural world as a collection of base material to be utilized to serve human ends. This understanding of nature comes into contradiction and demands a different relation to nature which need not replace instrumental reason, but instead goes beyond it. Therefore, the emergence of this new technology occurred in two ways, either out from the natural sciences and the technologies it produces, or out of theoretical investigation into nature and mind. Since the contradiction in the human understanding of nature occurs both conceptually and empirically, so too will the resolution of this contradiction appear both in the realm of reason and the realm of phenomena. In other words, biomimicry not only offers new technologies that integrate and mimic natural systems, but it is accompanied by a new understanding of nature and how we should relate to it.

Through technology we can come to develop new, more consistent, and symbiotic relations. This is because it is in technology that we can see our relationship to the natural world most clearly. As Marx claims: "Technology reveals the active relation of man to nature, the direct process of the production of his life, and thereby it also lays bare the process of the production of the social relations of his life, and of the mental conceptions that flow from those relations."[33] If we examine closely the reasons for the emergence of this new form of technology it will unveil a new relation to nature and new "mental conceptions that flow from those relations. Once this relationship is examined, the understanding of nature that produces it—that is, the epistemological reason for this relationship—must also be examined.

[33] Marx, *Capital Volume 1*, 493.

Biomimicry makes a claim that: "The integration of sustainability and community requires a systems perspective focused on the relationships among numerous stakeholders."[34] Stakeholders in this claim meaning both human beings and natural systems. This claim has Hegelian roots. It was Hegel, over a century before environmentalism and systems thinking became common terminology, who advocated for a view of life and human systems as integrated, co-dependent, interacting, and interrelated. This shift in thinking from a focus on identification and distinction, to looking at interrelationships and connectivity has much to gain from, and much to attribute to, Hegelian thought. As Hegel would assert, it is only now—at the moment where our sciences, technologies, and developmental theories coalesce—that we can see both the historical progression of our ideas, as well as the impact of our thought made real. As these new technologies emerge they will also provoke new though and reflection. This will in turn lead to a new self-understanding and identity with the natural world. This realization has provoked a shift in human thought toward systems thinking. Such thinking seeks out symbiosis with the natural world. It looks at natural processes in relation to the whole organic system. This shift in thinking will provoke a compensatory shift in human practices. What will the new role be for human practices and how will these practices help us to comprehend the world and ourselves?

Technology based on instrumental rationality has been the primary way in which human beings relate to and enframe the natural world. It represents the rationality of the human mind. Therefore it conflicts with the natural systems—which follow their own unique rationality—harming them in various ways. The technology that is emerging as a result of this disequilibrium, that is, this contradiction, is a new technology of symbiosis. It is an organic technology that

[34] Edwards, *The Sustainability Revolution*, 29.

references the logic of the natural world as well as human rationality, rather than singularly the human mind. Biomimicry is a technological response to the contradiction, the disequilibria, both experienced and anticipated, that has been brought on by the traditional treatment of nature by human beings. By learning from the natural processes already tried in the harsh dialectic of nature's intentional evolution, we can learn how to cultivate a symbiotic relationship to nature. We can learn how to replicate natural processes and capacities in order to create integrative and harmonious technologies, which account for the symbiosis of nature. Such technology takes account of the logic unfolding in nature and seeks to mimic that rather than control and force nature's hands.

The main concern facing these new technologies is whether they are authentically liberating and sustainable or just a further domination of the natural world by instrumental reason. This would be a powerful ruse on part of instrumental rationality. It may be the case that biomimicry represents a new and deeper technological enframing. What is fundamentally different about it is that it includes the natural world as a rational entity in its enframing. From a Hegelian point of view, the resolution of a contradiction always carries the contradiction itself along into the solution in a new sublated form. Biomimicry is not a solution to technological enframing. It is a rather a form of enframing that allows for a new relationship and engagement with nature. In this way it changes our experience of the world, and thereby or thinking. A further problem is that the examples provided may not necessarily show a shift in rationality, but just in how human beings relate to nature. Once again, if we embrace a Hegelian perspective, any change in nature or self reflects a change in rationality. This is because such a change is a rethinking of our relationship to the other (the other in this case being the natural world). The change in rationality that is occurring is that of human beings coming to see that our rationality is

nature's rationality. Therefore, because nature and the self share the same rational structure, it is not a new form of rationality that is produced, but rather the overcoming of a conflicting form of rational thinking and its alignment with that rationality of nature.

Human Practices as Technology: We Are What We Create

Historically there has been constant debate surrounding the concept of nature and human being's relationship to it. I suggest that the surge in environmental thought in our time reflects a philosophical shift in the human understanding. I suggest that we view epistemological shifts in relation to our technologies and our relationship to nature. Taking this approach illustrates the dialectical relationship between our knowledge, technology, and our relationship to nature. As our understanding of the world alters, so too do our actions, practices, and—most specifically for our discussion—our technologies. Furthermore, as our technologies and practices are enacted, we can reflect on them, thereby enhancing or altering our understanding of the world. Therefore, how we relate to nature is determined by the dynamic of our understanding of the world and our actions toward it. If we accept the statement at the beginning of this chapter made by Samuel Alexander and it is the case that "Science thinks nature, [and] philosophy comprehends it…" then technology is the mediating factor that engages with it.

Human thought is expressed through the technology it develops. This is because technology is the mediating factor through which human beings relate to the natural world. Marshall McLuhan, claims that all technology is a human extension. Hegel would agree, as he sees the products of human labor, technology included, as our mind externalized in the world. Technology is, therefore, the art of human extension. Technology is the materialization of human thought and cognition. It is the means by which the human mind manifests itself in relation to the natural world. As technology engages with nature, nature provides feedback to the human being

through experience and reflection on this experience. It is in this way that technology serves as a hybrid between cognition and nature. It is the mediating form that serves to bridge the human/nature divide. Unknown to most who use it, and to many who develop it, technology—as a product of the human mind—serves to bridge the distance between human thought and the natural world. As human thought is realized in the world through technological systems, human understanding is enhanced and progressively seeks closer unity with nature through the synthesis of technological and natural systems.

At first glance technology appears to be oppressive and foreign to nature. However, the oppressive relationship humans engage in towards nature cannot be maintained forever. It eventually becomes reconciled in the recognition of nature as a conscious rational entity from which we can learn from and engage with. Furthermore, because technology *is* the mediating factor between human beings and nature, new technological developments come to reflect this new understanding and relationship toward nature. There are two reasons why the human relationship to nature is shifting to become more sustainable. First, because nature cannot remain divided with itself. That is, as human beings are part of nature, we cannot maintain an independent or dominating position toward it. Second, due to the influx of empirical data resulting from the damage of natural systems, it is necessary as the only occupiable position. In other words, I claim that the reconciliation of our relationship to nature is not only logically necessary, because nature as a rational systems will always move toward equilibration, but also physically necessary, because the historical human practices which have been seen to be destructive to natural systems, cannot be maintained forever. Until there is a resolution, in the form of empirical sustainability and a sustainable understanding of the human nature

relationship, the conflict between human systems and natural systems will continue to play itself out along these lines and possibly even more destructive ones.

This is the result, I suggest, of a contradiction of the human understanding which produces in turn a contradictory relationship towards nature. This contradiction is twofold. First, the form of rationality through which human beings understand the world and relate to it is conceptually flawed because it is based on an "instrumental rationality." Instrumental rationality reduces all of nature to base calculable matter. What it seeks is the reduction of all things to their ratio of correspondence. I intend to show that this form of rationally relating to the world does not "correspond"—and thereby is not compatible—to the rationality of the natural world. This latter form of rationality is dialectical and systematic. Second, this contradiction in human understanding is empirically flawed because the products and results of our actions based on this form of instrumental rationality are systematically destructive to the natural world.

Technology is generated and formulated by the human intellect and then materialized as it is actualized in the world. After its actualization it is evaluated in accordance with human understanding, its productiveness in relation to human society, and by its effects on the natural environment. Instrumentally based technology, which stands in a contradictory relationship to natural systems, is being reevaluated today for its effects on the external environment and its lack of natural symbiosis. This form of technology is typically recognizable from its environmental impact, as well as its inability to interact harmoniously with natural systems. Instrumental rationality represents a logic and rationality of the human mind, and therefore conflicts with the logic of nature, harming it in various ways.

Lewis Mumford claims that a great degree of cultural preparation was required before a technological mindset—that is, human beings relating to and understanding the natural world in a

technological manner—was able to take hold and dominate all of culture. This preparation, I suggest, was achieved from a basic desire that originated in the human mind and was secretly directing it throughout the ages. Mumford states:

> The dream of conquering nature is one of the oldest that has flowed and ebbed in man's mind. Each great epoch in human history in which this will has found a positive outlet marks a rise in human culture and a permanent contribution to man's security and well-being… Fire-making, agriculture, pottery, astronomy, were marvelous collective leaps: dominations rather than adaptations.[35]

Domination is the key term here. Rather than adapt, a specifically natural trait that suggests a dialectical progression, human beings attempt to dominate nature and bend it to their will. Therefore it seems that our next step in self-preservation will not be the further domination of natural systems, but rather of technological symbiosis with them. Mumford claims as much: "Our machine system is beginning to approach a state of internal equilibrium. Dynamic equilibrium, not indefinite progress, is the mark of the opening age: balance, not rapid one-sided advance: conservation, not reckless pillage."[36] We are on the dawn of such a "positive outlet," which will either "mark a rise in human culture" or lead to our suffering and demise. The option now presents itself for human beings to embrace and flourish the natural systems at work in the world, or to slip away slowly into oblivion, leaving behind only a legacy of misuse and ruination.

Humans, as the highest mental stage of animal life, represent the negative of nature. The freedom of mobility and independence granted to the human being allows for human beings to effectively separate themselves from nature. This is achieved through the mental abstraction of the human subject, and its assertion that it is somehow independent of the natural world. However, this negative relationship cannot be maintained. Rather, it is through the mediating force of the human extensions of technology that this contradiction can be overcome. As our

[35] Mumford, *Technics and Civilization*, 37.
[36] Mumford, *Technics and Civilization*, 429-430.

technologies are in the final instance only reflections of our mind, and our beings, they are also relational extensions. In other words, technologies reflect our understanding of the natural world and thereby our relationship to it. If our understanding is one of humans in a dominating position separate from nature, and as the natural world as constituting only base entities stripped of all essence, then our technological relationship to nature will reflect that. If, on the other hand, our relationship is one of self-recognition with the natural world and of a systematic understanding of its relevance for us, then our technologies will likewise reflect this. Biomimicry, I claim, is a technological development grounded in a revised concept of nature. As opposed to the modern concept of nature as base material, this new understanding recognizes nature as systemic and self-relational. Such a position offers an emancipatory possibility for human beings, nature, and technology.

Like cognition, technologies are also developed from a needs based system. As human needs are fulfilled by the proper and efficient functioning of technologies, they become not only instrumental but seemingly inseparable to the operation of society. Here lies the root of technological reliance. As the mediating factor between human beings and the natural world, as well as the fluid extension of the human being itself, technology proves itself as a feature of human existence. This is how technologies can come to define the human experience. Heidegger called this mindset "technological enframing."[37] However, the world is always framed in a technological manner by human beings. This is how we mediate our relationship to nature and overcome our perceived separateness from it. What is not fixed is the technological form by which the world comes to be enframed. There is a great deal of difference between technologically enframing the world in accordance with dominating mindset that views it as base

[37] Heidegger, "The Question Concerning Technology," 32.

resources to manipulate and bend to fit our will—the enframing reflected in Heidegger's warning—and a technological enframing that views the world of nature as a complete system which human beings can learn and develop design, production, and integration practices from. The latter I argue is the technological stance of biomimicry.

CHAPTER 2

HEGEL AND DIALECTIC

Philosophy originates in dialectic; its universe of discourse responds to the facts of an antagonistic reality.[38]

This chapter focuses on Hegel and his theory of consciousness' development, for it contributes to a philosophical understanding of biomimicry. Perhaps the most important contribution Hegel makes to the understanding of consciousness and thus, I will argue, to biomimicry as well, is his articulation of a dialectical logic which I reconstruct in the first section of this chapter.

In the next section I present Hegel's theory of the development of consciousness. I trace the steps of this argument as Hegel himself presents them in the *Phenomenology of Spirit* (1807). The culmination of this development is the achievement of what Hegel calls absolute knowledge. It is at this point that the subject comprehending the world and the world, as a substance and collection of objects for the subject, collapses. This understanding shows all of reality to be the rational unfolding of what Hegel calls "the Idea."

In the final section I present Hegel's argument for all things—being, nature, history, social institutions, and thought—as being the dialectical fulfillment of one universal and absolute Idea. This would mean that Hegel develops an ontology that follows from—or more accurately coincides with— a logical idea. Hegel can now, with a dialectical system in place, outline a system of development for nature. Hegel's theory is central to the claim that I am making regarding the philosophical foundation of biomimicry. The interrelatedness that comes out of Hegel's theory guides biomimetic development which is seeking an integration between natural systems and technological systems.

[38] Marcuse, *One-Dimensional Man*, 125.

Hegel's Dialectic: The Labor of the Negative

Dialectic is the very nature and essence of everything predicated by mere understanding—the law of things and of the finite as a whole,[39]

Hegel's project, as it is set out in the *Phenomenology*, is grounded on the logical movement of the dialectic. Prior to any discussion of his overarching project, its inherent and necessary parts, or the final claims of his theory, we must first come to understand thoroughly the function of the dialectic and its component parts as they exist in Hegel's system. For Hegel all of reality is finite. The finitude of reality creates a process of change. Finite entities emerge, develop and dissipate, or are born, live, and die. There is a movement or desire, inherent, in finite things that drive them to the fulfillment of their potential. This logically leads to a dialectical state of affairs. Dialectic is the logic of this process of progression from one state of affairs or existence to another. If there is nothing static and unchangeable, how then does change emerge? Hegel says that it results from the playing out of the dialectic of the finite. He claims: "Everything that surrounds us may be viewed as an instance of Dialectic. We are aware that everything finite, instead of being stable and ultimate, is rather changeable and transient; and this is exactly what we mean by that Dialectic of the finite…"[40] Hegel is essentially claiming that everything is not only finite, in accordance with what science teaches, but that it follows a logical progression of change that moves it beyond itself while also maintaining all prior stages of development within itself. He calls this movement dialectic. In order to ensure that it does not collapse into stagnation, thought will "veer round" into its opposite to set up a contradiction.

[39] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 116.
[40] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 118.

This "veering round" or "passing into" opposites is the central progressive force of the dialectic.[41]

Dialectic is the logical structure of both thought and existence, according to Hegel. As the logical structure of all things finite, it represents not only conceptual reality, but also all of experiential reality as well. Hegel claims that: "Wherever there is movement, wherever there is life, wherever there is anything carried into effect in the actual world, there dialectic is at work. It is also the soul of all knowledge that is truly scientific."[42] For Hegel, the progression of all reality and thought is dialectical. He sees it as the structure of life and thought because each entity if formulated, progressed, and reconciled by becoming something other than what it is and then incorporating that otherness back into itself. Concerning the dialectical movement of thought, Hegel argues that it is in the nature of rational thought not to leave something unresolved and contradictory. A contradiction suggests that there still remains something other or outside. Since nothing can remain in opposition to itself, it is pushed toward reconciliation. This claim echoes Kant in the *Critique of Pure Reason* where he suggests that reason is naturally compelled to go beyond itself.[43] For Kant, reason does this by wrongly applying itself to questions to which it cannot ground itself or provide answers to (that is, metaphysical questions).

For Hegel, reason is also compelled to move forward and never rest in contradiction. This insight is what fuels Hegel's critique of Kant. He suggests that there can be nothing left outside of thought, so the mere idea of a thing-in-itself is a contradiction. Hegel suggests instead that reason or the Idea encompasses all things so (human) reason is also capable of knowing all things. As human beings develop consciously, they too are fulfilling the rational concept in the

[41] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 116.
[42] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 116.
[43] Kant, *Critique of Pure Reason*, 99/avii-aviii.

same way as a germinated seed or hydrogen atom does. What is unique in the human situation is that human beings possess the rational concept as subjective agents. This is why it is possible for human beings to see the rational nature in all things, because the rational Idea, which permeates all things, is coming to comprehend itself through the rational thought of the human subject. Hegel's metaphysics are directed and constituted by the Idea and therefore thoroughly rational.

The subject or substance begins with a negation (an inherent contradiction, opposition, or misunderstanding), which moves and forces the subject to a resolution. This resolution is contained within the original negation itself. It is the necessary completion of the negated subject. Comprehension of this necessity is only possible upon the logical completion of the negation. In other words, knowledge can only be reached in retrospect after the resolution of the dialectic. Wherever there is life, matter, being, or thought, dialectic is at work according to Hegel; it is what, "forces nature out of itself."[44] Dialectic is therefore the power of creation for both life and thought. Hegel very nicely describes this dialectical process when he claims: "But the true view of the matter is that life, as life, involves the germ of death, and that the finite, being radically self-contradictory, involves its own self-suppression."[45] Life, as finite, contains negation and contradiction. It is this movement of negation and reconciliation that defines life and its processes. I will now outline and demonstrate the logical moments of the dialectic.

The first stage of dialectic is the emergence of a particular. A universal becomes a particular when it becomes immediately present and certain. However, the particular contains within it contradiction. This results because the particular is never absolute or universal. Because a particular is only a part of the universal, there is a limit or contradiction that it encounters.

[44] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 118.
[45] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 117.

There exists or emerges a limit; an "other" to this particular that must be "taken back."[46] This moment is the recognition of contradiction or negation. Negation is the second moment of the dialectic. Hegel utilizes many terms for this crucial moment of the dialectical process: negation, determination, indifferent diversity, mediation, and difference. Regardless of the specific term—which helps to clarify the form of negation in some instances—the idea that he is conveying is continuously the same. Concerning the process of mediation or negation, Hegel states: "Mediation is nothing beyond self-moving sameness."[47] It is the "other" that emerges from the particular and must be taken back into itself to become complete. It is self-moving and same because it emerges from the particular, and in opposition to it. Its character is more that of a perceived false difference than an authentic irreconcilable difference. It contains in itself the capacity to be reconciled with itself, and in fact must necessarily do so. It is, therefore, only the difference of the same.

The negative exposes and recognizes what was taken for granted as immediate in the particular, producing a contradiction. The particular is necessarily related to an "other" for its identity and existence. This relationship creates conflict or contradiction, and thereby movement. Movement is present because the negation forces a resolution. It contradicts and opposes because the true relationship is that this particular and the other are self-same and identical. This is what Hegel means by "self-moving and self-differentiating thought."[48]

Consciousness cannot be sated within contradiction. It must have—and in fact constantly and actively seeks—wholeness and completion. This movement towards a "oneness" that contains identity and difference within itself is the "labor of the negative." This movement of

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[46] Hegel, *Phenomenology of Spirit*, 11, Hegel states: "The beginning, the principle, or the Absolute, as at first immediately enunciated, is only the universal."
[47] Hegel, *Phenomenology of Spirit*, 11.
[48] Hegel, *Phenomenology of Spirit*, 34.

negation is necessary to life because life is finite, and the logic of the finite is dialectical negation. All things that come into existence eventually pass away. This truth instantiates the dialectic, proving it to be the motive force of all things (both physical and conceptual). Since all beings progress by this dialectical logic, and because this is a rational progression, all things are permeated by rationality. This logical truth holds for all reality both material and ideal, which Hegel later shows are the same. We can therefore say that for Hegel there is only an 'Absolute Idealism,' or that, "Being is Thought."[49]

The final stage of the dialectic is a resolution to the contradiction in a universal that is able to reconcile the particular and the negative which emerges from it. Hegel calls this reconciliation sublation, or determinate negation—the negation of the negative. He claims: "Looked at as a result, what emerges from this (dialectical) process is the *determinate* negation which is consequently a positive content as well."[50] The result of determinate negation is a universal that sublates and maintains the particular as well as its negation in a new and greater form. The later part is central to understanding sublation. It is not as though the contradiction is resolved into a former state of stasis. Resolution is always a progression, a moving forward. There are no retrograde or static moments for Hegel. Finitude necessarily creates negation, which necessarily leads to sublation, thereby creating an advancing progressive movement. We can see here how biomimicry comes to represent the negative of instrumental technological development. It is a sublation of technology with the rational world, which technology previously negated itself from. Having now a firm knowledge of the dialectical movements Hegel presents in his theory, I will now move forward to Hegel's developmental theory of consciousness.

[49] Hegel, *Phenomenology of Spirit*, 33.
[50] Hegel, *Phenomenology of Spirit*, 36. Parenthesis mine.

From Consciousness to Absolute Knowledge: I that is We, We that is I[51]

Hegel begins his philosophical inquiry with a preamble: the *Phenomenology of Spirit*. This text is the retracing of the development of thought to bring this development to the conscious awareness of human-self-conscious-mind. In it Hegel demonstrates not only the conceptual development of the human mind, but also its social manifestations including its historical and material instantiations. I intend to outline Hegel's argument that leads him from the development of conscious awareness, to self-consciousness, to the recognition of social reason in the form of Spirit, and finally to the "Scientific" systematic knowledge that unites spirit or the Idea with all things. Once this awareness is achieved, we can according to Hegel elaborate a philosophical system that initiates in the abstract, actualizes in the physical manifestations of existence, and finally comprehends itself completely in the concrete embodiment of the abstract mind which is truly aware of what it is as mind (that is, as all things). This awareness is the achievement of the *Phenomenology* and can only be discussed after the understanding it suggests is fully comprehended. The results of the *Phenomenology* are the guiding presuppositions for Hegel's later philosophical system.

The *Phenomenology* is to be conceived as the preamble to all philosophical thinking. The culmination of the *Phenomenology* is human being coming to properly know the true dialectical nature of things, and to see all of existence as constituted by the rational Idea. It puts forth the dialectical becoming of consciousness. Development begins and ends with consciousness and its relationship to both itself and objects. The first stage begins with simple natural consciousness and through its necessary development leads to the emergence of self-consciousness. Consciousness begins with "sense-certainty," which is the most immediate knowledge available

[51] Hegel, *Phenomenology of Spirit*, 110.

to consciousness and presents itself as certain and true.[52] At this stage raw sense data about the world of objects is comprehended as true knowledge. What this state of mind consists of is a direct, and perceived true, interaction through the senses between consciousness and objects.

What then is consciousness' role in sense-certainty? Hegel argues that: "Consciousness, for its part, is in this certainty only as a pure 'I'; or I am in it only as a pure 'This', and the object similarly only as a pure 'This'. I, this particular I, am certain of *this* particular thing..."[53] Just as in all stages of conceptual development, at this early stage of sense-certainty we can see that self-understanding is determined by the understanding of objects or "other" in the world. We perceive an object as a particular, as a simple 'this', and this knowledge grants us self-knowledge. We then come to understand our self as a simple and particular this. This is the essence of knowledge in sense-certainty, which Hegel calls "simple immediacy."[54]

The certainty of sense-certainty does not last because as we come to understand objects, we also come to understand that there is a negative element that determines their particularity. There is always a negative element present when consciousness attempts to particularize and preserve a specific object. Moreover, this negative is what allows for identification in the first place. What consciousness comes to understand is that sense-certainty is not immediate as was supposed and is in fact mediated. Our understanding of objects—what differentiates this rock from that rock over there, or the rock experienced yesterday, or a year ago for that matter—demands that there be something to distinguish. That is, some kind of overarching shared "rockiness" which unites these seemingly common entities. Hegel calls this the Universal.

[52] Hegel, *Phenomenology of Spirit*, 58.
[53] Hegel, *Phenomenology of Spirit*, 58.
[54] Hegel, *Phenomenology of Spirit*, 59.

This realization leads consciousness to the next stage. Consciousness now takes the universal as the true knowledge of objects. This new truth also provides a new understanding of the self as well: "'I' is a universal and the object is a universal."[55] However, the universal of perception is not a true universal. This is because perception is still being determined by the object rather that the subject. This knowledge of the world cannot be maintained and comes into contradiction when consciousness observes the interaction of forces. Eventually the mind is established as the active force which constitutes the objects through the Understanding and not the other way around. It is by the power of the Understanding that consciousness comes to realize that perception constitutes the object of experience to some degree.

With the development of the Understanding, certainty is granted. It appears at this stage that consciousness has reached a sublation of sense-certainty and perception in the universal 'I' of the Understanding, which is determining or mediating objects of experience and thereby granting certainty. The world then becomes determined by the Understanding and the "I" is given power over the world in the form of judgment and negation. This subject, "I," or transcendental ego is the prized achievement of modern philosophy. Much of philosophy since the development of the abstract transcendental ego (Hegel included) is spent trying to concretize or rematerialize the subject from this abstract position. Regardless, this certainty of the Understanding also comes at a cost. The cost is the supersensible world beyond appearance, or the thing-in-itself. It is therefore clear that consciousness cannot settle and must move forward to address this problem.

As the subject, comes to realize that the objects of experience are formulated by itself, that is, the "I," it comes to the knowledge that what it experiences is a product of itself. This

[55] Hegel, *Phenomenology of Spirit*, 67.

knowledge leads the subject to see itself as constituting the world, and therefore it considers *its* reason as the essence of the world. However, there is a contradiction in this knowledge and understanding of the world, which pushes the subject to seek yet another resolution. As in all first stages of the dialectic, the former universal becomes the new particular for self-consciousness. We also discover from Hegel that the nature of self-consciousness is "*Desire* in general."[56] This is because self-consciousness is embodied and part of life, and life is desire according to Hegel. What are the objects of self-consciousness' desire that develop its self-knowledge? There now exist two objects for self-consciousness. The first being the sensuous object of experience, and the second being self-consciousness itself. Self-consciousness desires and satiates its desires through the negation of objects. This is what Hegel means when he claims, "…(self-consciousness) destroys the independent object and thereby gives itself the certainty of itself as a *true* certainty."[57] This is the power of determination granted to self-consciousness by the Understanding.

Self-consciousness receives its knowledge of itself, its self-understanding, by its reflection on the world. The knowledge it gains from the object and the world is simultaneously self-knowledge. Self-consciousness, through its action/negation of objects in the world, has come to see that it is enslaved and dependent on the objects it negates for the fulfillment of its desire. Also self-consciousness cannot gain recognition or fulfillment from the objects it negates. Hegel makes this idea expressively clear:

> In this satisfaction, however, experience makes (self-consciousness) aware that the object has its own independence. Desire and the self-certainty obtained in its gratification, are conditioned by the object, for self-certainty comes from superseding this other: in order that this supersession can take place, there must be this other. Thus self-consciousness, by its negative relation to the object, is unable

[56] Hegel, *Phenomenology of Spirit*, 103-105.
[57] Hegel, *Phenomenology of Spirit*, 109. Parenthesis mine.

> to supersede it; it is really because of that relation that it produces the object again, and the desire as well. [58]

Desire shows self-consciousness its own dependence on the object of desire. A good example here would be water or air. Both are objects of desire; however, consciousness can never become independent of them because they are necessary to consciousness, which is dependent on them for life. Self-consciousness comes to realize that its desires can only be satisfied by coming to see its dependence on objects. Specifically its dependence on objects like itself, that is, other self-consciousnesses.

Self-consciousness seeks an "other" that contains its independence and capacity for negation. What it desires in this other is the reflection and the experience of its own freedom. Because self-knowledge comes from consciousness engaging with objects in the world, the next logical step is for self-consciousness to treat another self-consciousness as an object. This leads to an interesting dynamic because this other is also free and trying to assert its power to determine as well. This leads us to the next section of self-consciousness: Lordship and Bondage. What self-consciousness is seeking in this relationship is recognition or acknowledgement from an "other" like itself. It desires to see its freedom in another entity or object like itself.

This engagement for recognition is arduous and complex. First, self-consciousness encounters another self-consciousness. It identifies with this "other," which is like itself. As Hegel claims, "…(self-consciousness) does not see the other as an essential being, but in the other sees its own self," and therefore, "…it must supersede this otherness of itself."[59] The desire to supersede the "other" results in a conflict between the two entities. Self-consciousness

[58] Hegel, *Phenomenology of Spirit*, 109.
[59] Hegel, *Phenomenology of Spirit*, 111. Parenthesis mine.

engages in a "life-and-death struggle" in order to gain independence.[60] What results from this conflict is either the death of a self-consciousness, which grants no understanding or recognition, or the unequal arrangement where one self-consciousness submits in an attempt to preserve its own life, resulting in the relationship between lord and bondsman.

The relationship that emerges from the "life-and-death struggle" is inherently unstable and contradictory. First, it places one self-consciousness, the bondsman, in a subordinate position denying it independence and recognition as a free being. For Hegel, this means that the defining characteristic of the human being (its freedom to negate) is denied to it, making it a base object of another's will. Its freedom is curtailed and its power to negate now serves "for another" and it is no longer its own. Secondly, the lord is not granted the recognition of freedom from the bondsman because recognition is only granted by a free individual self-consciousness.[61] In this unequal relationship, the bondsman has the capacity to determine only as a medium for the expression of the freedom of an "other" (the lord). The lord can gain no satisfaction because it is only viewing its freedom enacted through an "other" treated as object, and not the free act of another's freedom. Because the bondsman is not free, it cannot grant this recognition. The bondsman, having lost independence and reduced to carrying out the lord's will, has lost the capacity to grant recognition in its current position.

However, there exist an emancipatory moment for the bondsman in the form of labor. Hegel claims that: "Through work, however, the bondsman becomes conscious of what he truly is."[62] It discovers, just as consciousness does at every stage of development, that as it works over the world, it has the independent power of negation/determination. Resolution of this conflict can

[60] Hegel, *Phenomenology of Spirit*, 114.
[61] Hegel, *Phenomenology of Spirit*, 117.
[62] Hegel, *Phenomenology of Spirit*, 118.

only come through the mutual recognition of each self-consciousness of the freedom of the other. It is then that self-consciousness gains real freedom and self-knowledge. Only when there is mutually recognized freedom in equal dependency can self-consciousness be satisfied and advance its self-knowledge. This leads to the next and final section of the self-consciousness stage.

In this stage, Hegel presents self-consciousness as an independent and more importantly as a thinking subject. This was the benefit that was granted to self-consciousness in the form of recognition in the "life-or-death struggle." Self-consciousness now sees itself in the world. There now exists an object for self-consciousness to conceptually consider that is exactly like it, and which reflects its own being back to it. The recognition that self-consciousness is granted from this "other" is reciprocated because these consciousnesses are necessarily the same.[63] Consciousness' understanding is now complete enough for it to encounter and recognize reason. By recognizing the reason and freedom of other self-consciousnesses along with the knowledge that human beings are actively constituting and determining the world, consciousness comes to know spirit. What this entails is the comprehension that consciousness is the world, the objects of the world, and that reason permeates and drives all of existence. It is also the knowledge that human society and history represents the coming of this knowledge. Spirit is the collective consciousness of a society which is the materialization of the Idea coming to know itself in the world and seeing reason or the Idea (itself) in all things. There now exists the possibility and foundation for science. However, the journey is not complete as there are many misunderstandings that consciousness must now "labor" through before it can rest free of conflict and contradiction.

[63] Hegel, *Phenomenology of Spirit*, 112.

There is now a truth for consciousness labeled subjective idealism, in which consciousness is identified with the world.[64] Consciousness may now understand itself to be in and constitutive of the entire world. However, like all stages of conscious development it must prove and demonstrate this realization through action. Like all dialectical beginnings, reason begins with a truth or certainty and then tests it. It has come to know that reason is the world, now it must see reason manifest in the world and in all things. Reason observes itself in three moments for Hegel providing the further insights into consciousness that I will now briefly discuss. The first observation of reason is the observation of nature. Through this process, consciousness comes to apply reason to all of nature—including what Hegel distinguishes as organic and inorganic beings—resulting in the discovery of rational scientific laws. Having gained this understanding of nature, reason then turns to conceptual entities, logical and psychological laws, or what Hegel calls "Laws of Thought."[65]

This application of reason gives consciousness insight into its "constructed" and "constructing" nature. This is possible due to the individual's actualizing, or as Hegel says "transforming," the world that the individual comes to know itself. It is through the reworking of the world by the human mind that human beings come to knowledge of the world, including self-knowledge. In Hegel's words:

> If these circumstances, way of thinking, customs, in general the state of the world, had not been, then of course the individual would not have become what he is…Individuality is what *its* world is, the world that is its *own*. Individuality is itself the cycle of its action in which it has exhibited itself as an actual world, and as simply and solely the unity of the world as *given* and the world it has *made*; a unity whose sides do not fall apart, as in the conception of psychological law, into a world that *in itself* is already given, and an individuality existing *on its own*

[64] Wartenberg, "Hegel's Idealism: The Logic of Conceptuality," 105.
[65] Hegel, *Phenomenology of Spirit*, 180.

account.[66]

There is a form of mutual determination between the world and the individual. Through its changing relationship and shifting identification to the world, the human being forms its identity. Furthermore, the individual is also capable of freely transforming the world, which in turn transforms the individuals creating a self-generating cycle. This interrelated nature of the world and the individual is central to not only understanding Hegel's theory, but also the true extent of his influence. There is present a mutual reification, if I may use this term, of the individual and the world via actualization or labor. This dynamic occurs historically and the products of its playing out are likewise historical. This is precisely what Hegel means when he claims that "…each individual is in any case a child of his time..."[67] What he is suggesting with this statement is that every thinker—and by extension the products of their thought—are historically and socially conditioned.

From this point reason moves to the individual physical body of self-consciousness. This is an attempt to formulate laws or sciences that will explain particular individual differences. These differences that reason is hoping to establish in a law-like manner in the individual are expected to be reflective of particular non-physical mental characteristics. It is essentially an attempt to find or locate consciousness in the individual's external physical structure. These attempts to make manifest the individual internal characteristics in an external or physical form result in the false sciences of physiognomy and phrenology. What these "sciences" attempt to accomplish is to observe the inner of the individual as "reflected out of his actual being."[68] They will (and do) fail according to Hegel because consciousness is not corporeal. It can manifest

[66] Hegel, *Phenomenology of Spirit*, 184-185.
[67] Hegel, *Elements of the Philosophy of Right*, 21.
[68] Hegel, *Phenomenology of Spirit*, 190.

itself in the actuality of the individual, as well as the rational laws and systems of the natural world, yet it cannot manifest itself in the external physical traits of the individual. Individual physical construction is reason (in that it is rational and obeys laws); however, it is not reflective of individual consciousness regardless of how much consciousness is affected or constructed by it.

From this point reason (rational self-consciousness) will move on to consider actuality, and how from it there emerge laws in the social realm. Every truth that consciousness acquires emerges in actuality. This is consciousness' manifestation in the world. It is a form of labor in that consciousness is making the world in into its image, and then reflecting on what is actualized in order to gain self-understanding. Any inconsistencies or contradictions emerging from actualization must be "worked" through and addressed before consciousness rests in completion. This dialectical process is systematic and repetitive at every level of development, as Hegel states:

> Just as Reason, in the role of observer, repeated, in the element of the category, the movement of *consciousness*, viz. sense-certainty, perception, and the Understanding, so will Reason again run through the double movement of self-consciousness, and pass over from independence into its freedom.[69]

In similar form to all of Hegel's progressions of consciousness, this one will not only take on the form of a three-fold dialectic but will also repeat—in a new way—the former stages of consciousness. As with the first stage of self-consciousness, so reason too begins with desire or appetite. Taking itself and its desires for certain and immediate, reason acts on them in a direct and individualistic way.

At this point we move forward into the second stage of the actualization of self-consciousness. During this moment, self-consciousness maintains a law that it knows

[69] Hegel, *Phenomenology of Spirit*, 211.

individually and immediately called the "law of the heart." This immediate certainty of the rightness of the law of the heart leads to the "frenzy of self-conceit." This frenzy results from the individual attempting to enact their law on all, and thereby attempting to make it a universal. Conceit enters in because the individual feels right in doing this and also considers the imposing of its law "the universal pleasure of all mankind." However, contradiction emerges when the law of the heart is manifested because it is depersonalized and removed from the individual. It thereby becomes alien to the individual and the individual subsequently becomes hostile to it.[70]

From this hostility there emerges a new consciousness that "knows it must sacrifice the individuality of consciousness," which is called virtue.[71] What virtue demands is sacrifice and discipline of the individual and its desires. It seeks to enact a principle of action from a moral principle. However, virtue fails because no matter how good, morally right, or "implicitly true" the principle is, it is not in accord with what Hegel calls the "way of the world."[72] The way of the world is the reality of necessity facing self-consciousness, which it cannot simply turn away from. It is the actual working of the world, not the way that it ought or should be. The result then is that virtue—this self-effacing individual moral dictation from an abstract principle—fails in the reality of the way of the world. There then emerges a new truth in the way of the world. Hegel argues that:

> The *labour* of the individual for his own needs is just as much a satisfaction of the needs of others as of his own, and the satisfaction of his own needs he obtains only through the labor of others. As the individual in his *individual* work already *unconsciously* performs the universal work as his *conscious* object; the whole becomes, as *a* whole, his own work, for which he sacrifices himself and precisely in so doing receives back from it his own self.[73]

[70] Hegel, *Phenomenology of Spirit*, 221-223.
[71] Hegel, *Phenomenology of Spirit*, 228.
[72] Hegel, *Phenomenology of Spirit*, 230.
[73] Hegel, *Phenomenology of Spirit*, 213.

From the failure of virtue, consciousness comes to realize that individual action and the pursuit of individual desires is consequently a "universal action."[74] By acting in accordance with its own self-interest and by fulfilling its desires, the individual necessarily contributes to the social benefit of all. The individual has now come full circle and gained a great realization. Its labor is not simply his own. By working for itself and its own desires, it simultaneously works for others and the social as well. Hegel calls this "being-for-another," and it manifests itself in the laws, institutions, and the customs of a society. With the actualization of this stage in the final section of Reason, we have achieved Spirit. Through this realization and knowledge, we can now think philosophically and have a science for knowing the world. From a Hegelian viewpoint, the logical unfolding of the Idea in history necessitates technological development. However, progress does not halt with the achievement of instrumental technology. Spirit must now take a further step and bring this development, which has removed or negated itself from the natural world, full circle by uniting it with nature. I argue that this is precisely the role of biomimicry.

Nature and the Logic of the Finite

Hegel can now begin his project over again, but in a new sense. Now that we can begin philosophy for Hegel, we can account for the development of the Idea as a science. Recall that for Hegel knowledge comes only at the end of the process. The *Phenomenology* is an account of the development of consciousness to spirit and absolute knowledge. This development occurs not only in the mind, but also in the world. It accounts for both mental and historical development. In other words, it is an account of the Idea coming to know and be conscious of itself through the world and human self-consciousness. Because this is a historical development, social institutions, human practices, religions, art, and I would argue technologies are manifestations of this

[74] Hegel, *Phenomenology of Spirit*, 235.

development of consciousness. The connection between consciousness' development and the natural world is central to understanding the philosophical implications of biomimicry, or any new technology for that matter.

The *Phenomenology* ends with absolute knowledge and the possibility of "Science." In Hegel's view, science is a system of knowledge and a way for self-consciousness to rationally comprehend the world and itself. Science is only achieved at the end of the *Phenomenology* and is a prerequisite for philosophy. Hegel claims that the "Truth is in the whole."[75] With this claim he is suggesting that knowledge is not only systematic, but can only be realized at the end of the process. This could be the process of nature coming to realize the Idea through human beings (because we are after all nature/animals), the process of the human being developing a conscious mind capable of knowing the Idea, or of spirit realizing the Idea socially through institutions, laws, art, or religion. In any case, it is only at the end once the process has been completed that we have truth, because "Truth is in the whole."

Once we have comprehended the development of consciousness "scientifically," we can think through the development once again. Only this time armed with the knowledge of what it means and where it leads. Hegel begins with the most abstract form of the Idea, the logical form, and shows how it develops dialectically. The Idea as externality creates an "other," a negative of itself, which develops and can be conceived as perceptual reality. Through the physical dialectics of spatial-temporal reality, the dialectic develops into all of the inexhaustible forms of what humans call the natural world (this includes the human being itself). The eventual end goal of this natural development is human-self-conscious-mind achieving absolute knowledge of itself as

[75]Hegel, *Phenomenology of Spirit*, 11.

spirit. With this we have not only arrived at the truth of Hegel's *Phenomenology*, but have also presented a "scientific" philosophical account of how all of reality develops.

Hegel begins his philosophical work with what could be argued is a cosmology. It begins with the Idea, the pure concept, absolute and complete. However, this Idea exists only abstractly. This Idea forms externally in order to reflect on itself, and thereby to come to comprehend itself. The logical process of working through the dialectical stages of thought, beginning with being to non-being to becoming, coincides with the physical and existential working out of physical forms (from space to time to motion). Hegel states the contemporaneousness of this development: "The object of Cosmology comprises not merely nature, but Mind (*Geist*) too, in its external compilation in its phenomenon—in fact, existence in general, or the sum of finite things."[76] The goal that is being worked toward in this process is the self-awareness of mind of what it truly is. This process of discovery necessarily involves the natural world.

The culmination of spirit occurs through the intuitive perception of the human subject on all of reality. This realization can only occur after the natural world has unfolded dialectically in all of history, allowing the Idea to flourish with self-conscious spirit. Hegel states: "The Idea which is independent or for itself, when viewed on the point of this unity with itself, is Perception or Intuition, and the percipient Idea is Nature."[77] Hegel is claiming that the Idea "for itself," or the Idea fulfilled and more importantly actualized, is nature perceiving itself through the subjective "I" of perception. The Idea for itself is independent and free, and more importantly has the power of determination or negation. The "percipient Idea" that Hegel is elaborating here is the human being, come out from nature to know the world and to recreate both itself and the world. The human being is the Idea sublated for Hegel. It is the abstract (the Idea) emerging

[76] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 55.
[77] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 296.

from concrete actuality (nature) in the form of a concrete actuality capable of abstraction and the freedom to determine.

This process of development is simultaneously abstract, physical-natural, and historical. Proper knowledge of this process is relevant for two reasons. First, this is because human beings exist as the all-powerful spirit which determines and acts freely in the world, and second, because the relationship between human beings and the natural world is itself critical to the process of human beings coming to self-knowledge. If this process is interrupted or uneven in any way, then self-knowledge is directly affected, for better or for worse. Hegel's treatment of nature has great significance, specifically in how human beings know and conceptualize the natural world and thereby come to self-knowledge. The examination of this process and Hegel's philosophy of nature will remain to be discussed in the next chapter.

CHAPTER 3

NATURE AND DIALECTIC

The separation of science from philosophy is itself a historical event.[78]

The focus of this chapter is on Hegel's theory of natural development. I will be looking closely at his *Philosophy of Nature*. Just as Hegel's theory of the development of consciousness moves dialectically to the realization of spirit, so too is the development of nature the progression of the Idea in its external form to spirit and self-realization. Thinking about nature as having both a rational progression and a rational impetus to overcome limitations and contradictions is the first step in knowing nature as problem solving in the way that biomimicry does. This way of thinking originates with Hegel. The first section of this chapter will outline Hegel's philosophy of nature. His system—as presented in the *Phenomenology* and further elaborated in the *Logic*—leads him from a elaboration of a pure logic to the development of nature. There are two features of his *Philosophy of Nature* that I wish to focus on. The first is the conscious intentionality of the natural world. This concept is expressed most clearly in the section on "Organics" or biological life. The second is the duty Hegel sees that human beings have to work over the natural world. This working over nature is necessary in order to both secure their existence, as well as to attain (self) knowledge.

In the final section of this chapter I address critiques of his theory. I argue that the parts of his theory that are challenged or found lacking do not suffice to dismiss the theory *en toto*. Rather, I suggest that this theory of natural development, which shows the interconnectedness of life-systems and intentionality in nature, is better suited to explaining our technological advances, as well as our shifting social and institutional practices, than the concept of nature

[78] Marcuse, *One-Dimensional Man*, 186.

advanced by the natural sciences. Therefore, his system cannot be simply avoided or dismissed. Much can be gained from his *Philosophy of Nature*, not only in terms of elaborating his philosophical system, but also I suggest for understanding our current concept of nature.

Philosophy of Nature in Hegel: The Fulfillment of the Idea

> The Philosophy of Nature may perhaps be regarded prima facie as a new science; this is certainly correct in one sense, but in another sense is not. For it is ancient, as ancient as any study of Nature at all; it is not distinct from the latter and it is, in fact, older that physics…It is only in modern times that the two have been separated.[79]

When a specific work of a philosopher that has been historically disregarded, dismissed, and disavowed is not only mentioned multiple times by current thinkers but also argued for having value and use for our contemporary thought, then that formerly disregarded work no longer takes the role of an obscure loose brick of that philosopher's system to be cast aside, but rather becomes a foundational column for comprehending that system properly and in its entirety. Such is the case of Hegel's *Philosophy of Nature*. Due to selective and superficial readings of this work, it has been historically ridiculed as unnecessary to Hegel's system of thought or dismissed as outdated in its treatment of the natural sciences.

I would suggest that such dismissals are developed as an argumentative strategy from (and with the purpose of maintaining) the traditional empirical epistemological standpoint. The metaphysical assumptions Hegel's natural philosophy critiques—that is, the assumptions which serve to "ground" the natural sciences—challenges the metaphysical foundations of the natural sciences. Therefore, the natural sciences have a vested interest in criticizing or outright dismissing Hegel's critique. The dismissal of Hegel's *Philosophy of Nature* serves to strengthen and legitimate the dominant epistemology of the natural sciences. Unwilling to allow any threat or challenge to the metaphysical underpinnings that project it, modern science, most thoroughly,

[79] Hegel, *Philosophy of Nature*, 2.

either attacks or disregards Hegel's *Philosophy of Nature*. In spite of this, and in proper Hegelian fashion, the logical truth of nature cannot be argued against and refuted, only postponed. Such truth, I will argue in the following chapter, is now becoming materialized in the technological practices of biomimicry.

Hegel argues that the inseparable development of Idea, Nature, and Mind occurs not only logically but also contemporaneously. The development of any one is *not* temporally prior to any other. Alison Stone claims, in her excellent text on the subject, that:

> [Hegel] does not mean that nature emerges from logic in a temporal sense. Presumably, he understands nature's emergence in the same way as the other developments…within nature—so that logical thought transforms itself into nature eternally and unceasingly (not in a single act of creation, but in an ongoing process of generation and regeneration).[80]

This concept is central to Hegel's system. The first presumption that Hegel starts with is that of "pure being."[81] As Hegel develops his logic, pure being gives way to becoming, and eventually to the realization that nature is this becoming of being. What Hegel is claiming is that the logical development of the Idea, while in fact presented first in his philosophical system, develops with nature. Stephen Houlgate claims, regarding Hegel's transition from the *Logic* to the *Philosophy of Nature*, that: "For Hegel…there is no 'being' prior to nature: nature is all there actually is."[82] This is a difficult overall vision to maintain in the forefront of our minds when working through the details of his component systems.

Just as the *Logic* begins with the most abstract concept and moves toward more developed, complex, and concrete concepts, so too does the *Philosophy of Nature* begin with the most abstract forms of externality and then moves to the more concrete. In fact, Hegel states in

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[80] Stone, *Petrified Intelligence*, 97. Brackets mine.
[81] Houlgate, *An Introduction to Hegel*, 37.
[82] Houlgate, *An Introduction to Hegel*, 107.

the final sentence of the *Logic* that, having just established and presented the purely logical progression of the Idea, we must now turn our attention to the Idea in its external existence. Hegel states: "We have now returned to the notion of the Idea with which we began. This return to the beginning is also an advance. We began with Being, abstract Being: where we now are we also have the Idea as Being: but this Idea which has Being is Nature."[83] This final statement to the final section of the first part of the *Encyclopedia* is meant to be a transitional statement leading the reader from the *Logic*, as the unfolding of the abstract Idea, to nature, as the unfolding of the externalized Idea. There is nothing to indicate that the logical progression of the Idea is somehow anterior to its externalized unfolding in the material world. Rather, Hegel is simply describing and presenting these different forms of progression independently of their relation to each other.

Hegel begins his inquiry into nature with space and time. These abstract external forms of the Idea begin to develop through their own contradictions to form matter and motion, finally culminating in what Hegel defines as Mechanics.[84] Out from these developments of progressively more complex forms of externalization the laws of physics are produced. They are the material logical expression of the unfolding development of the Idea in nature. In other words, as the externalized Idea progresses and becomes more complex it eventually forms and develops in accordance with the physical laws which serve to govern its movement and growth.

It is only by the development of the externalized Idea (nature) through the physical laws of matter to what Hegel classifies as organics that the biology of life emerges. It is here that we have the development leap from the physical structure of reality to the introduction of an organic structure of life. If the physics is the component system that is the source of much Hegelian

[83] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 296.
[84] Hegel, *Philosophy of Nature*, 44.

criticism, the organics on the other hand has been seen by other thinkers as contributing to scientific thought. It is in the section of organics that Hegel's evolutionary predisposition can be seen. Years prior to Darwin, Hegel posited that biological life must have developed systematically, historically, and hierarchically. Samuel Alexander argues that Hegel's *Philosophy of Nature* is an evolutionary philosophy. He claims that:

> Hegel's philosophy is in fact an evolution, called by the name of dialectic, which is the counterpart in philosophy of what evolution is in science…evolution is a history of how things in nature come to pass; dialectic is the process by which one idea logically leads on to the higher idea which is implicit in it and is its truth. Evolution is a history in a process of time; dialectic is a history of ideas which form a process not in time.[85]

Hegel, specifically in the section on organics, anticipates evolutionary biology. Furthermore, his dialectical theory of philosophy of nature helps us to understand the advances in evolutionary theory that have taken place since his time. This relationship between Hegel and the theory of evolution will be discussed in more detail—along with other critiques of his natural philosophy—in the final section of this chapter.

The organics begins with the terrestrial organism. It is this treatment of the earth as an organism, as a complete developing organic system of life, which clearly displays Hegel's systematic thought. Concerning the terrestrial organism Hegel states: "Thus the geological organism (the earth) is alive, not in its separate parts but only as a whole."[86] This thinking predates by a good one hundred years any modern concept of Gaia or Spaceship Earth.[87] Hegel is

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[85] Alexander, "Hegel's Conception of Nature," 518.
[86] Hegel, *Philosophy of Nature*, 303. Parentheses mine.
[87] Fuller, *Operating Manual*. See also Schroyer, "Critique of the Instrumental Interest in Nature," 160. Schroyer claims: "Most significant for international socioeconomic discourse, a new organic concept of the earth is forming. If the Gaia hypothesis is correct, the earth is not a "spaceship" to be maintained by human planetary engineers. This technological metaphor continues the unconscious forms of technical control that must be transcended… "Nature" is not, as the modern myth of progress suggests, amenable to endless interventions the secure

suggesting that the earth is a living system which, when taken in its entirety, supports and develops various other forms of life. Out from the development of the terrestrial organism comes biogenesis, which eventually leads to the next stage of development that Hegel calls "plant life."

It is in plant life that there develops what can be called awareness. Just as in similar form to the progression of biological life systems, so too does awareness and mind likewise develop in complexity alongside these systems. In plant life, organisms are vested with potentiality and sensory attributes. These attributes are directly linked to the organism's survival and propagation.[88] In a rather enigmatic passage, Hegel shows how the terrestrial organism (which is also referred to as the "merely explicit organism" or "physical nature") produces out of itself the vivified organism (plant life):

> [The vivified organism]…is the subjectivity which differentiates itself into members and which excludes from itself, as an objectivity confronting it, the merely *implicit* organism, physical Nature in its universal and individual forms. But at the same time, it has in these natural powers the condition of its existence, the stimulus, and also the material of its process.[89]

The terrestrial organism divides itself into the "separate members" of plant life or the vivified organism. As it excludes or mediates itself from the "implicit organism" (physical nature), it also sets itself (plant life) against itself (physical nature). Physical nature therefore takes the role of an "objectivity confronting" plant life. What remains from this division, just like in all levels of division for Hegel, is a systematically dependent mutual reification of plant life (or life in general) on physical nature for the "conditions of existence." Hegel uses "conditions of

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socioeconomic development." The origins of Gaia theory are already present in Hegel's concept of the terrestrial organism. Allowing that the earth is a terrestrial organism, adapting and living throughout history, rather than a spaceship to be controlled, redirects human thinking and our self-understanding in relation to nature.

[88] Passino, *Biomimicry for Optimization*, 60. Plants not only move and track sunlight, but they also direct root growth to nutrient rich soil.

[89] Hegel, *Philosophy of Nature*, 299.

existence" as a term for the necessary components needed to support both an individual and a system of life.

This all leads Hegel to classify plant life as immediate. The immediacy of plant life is due to its direct and unmediated relation to the terrestrial organism and the physics of the natural world for its survival and propagation. Plant life has a direct relationship to the terrestrial organism (in the form of soil, water, and gases to name just a few of the elements provided to plant life from the terrestrial organism) and the sun from which its nutrients and energy can be extracted. This form of organics shows at the most basic level the necessary relationship that all life shares with its environment for both its perpetuation, survival, and for its conditions of existence. According to Hegel, this development demonstrates how life has progressed from the more abstract externalized forms of matter to more specialized forms which progress systematically toward freedom and the realization of the Idea. This development entails necessity because as systems become more complex, emerge from, and build upon one another, they become thereby mutually dependent. Regardless of the amount of freedom achieved, the interaction and direct connection to the environment—which can be most clearly seen in all levels of life—can never be completely overcome.

Just as the organism bends to the environment for survival, it also shapes the environment to create a beneficial state for itself. It is in relation to the specialized ecological systems of nature that Hegel's systematic view of reality shows its true value. As plant life thrives, it creates soil and climate conditions which are beneficial to it. It also molds itself on the environmental system it inhabits. Such a relationship thereby creates a direct cyclical relationship between plant life and its localized environment. Here we can see the importance of intentionality and rationality in the development of all stages of life. As the living systems which make up all

reality develop, they also become increasingly interdependent through mutual reification and their constant interactions. This provides evidence and support for Hegel's claim that all life is enacting and fulfilling the Idea. The limit of plant life is that, despite its capacity for procreation and environmental influence, it is stationary and restricted in its movement and therefore restricted in its development. Such restriction is overcome by Organics in the next logical development of life: Animal life.

Hegel distinguishes plant and animal life in what seems like a very small, yet essential division. The intentionality of plant life is to complete its life cycle and fulfill what Hegel calls its "subjective vitality." He claims that "…the goal of the plant's development is to become for-itself."[90] What he means with this claim is that the purpose of plant life is to fulfill its subjective potential. It achieves this by realizing its potential in relation to its environment and by propagating itself. Plant life then seeks out an "other" to complete itself. For Hegel, this other is provided by animal life. Animal life is mediated through plant life. It requires plant life (either in the direct form of consumption, or through the consumption of other animals which relied on the consumption of plant life) for survival.[91] Regardless of the level of mediation, animal life—unlike plant life—cannot extract its conditions of existence directly and solely from the physical world. The level of mediation between animal life and the physical world is essential in that it provides animal life with its freedom.[92] Freedom for animal life is the advancement to mobility and its release from the stasis of plant life. This development gives support to Hegel's claim that life progresses into greater and greater levels of complexity. Each development builds

[90] Hegel, *Philosophy of Nature*, §350, *Zusatz*, p.351.
[91] Colinvaux, *Why Big Fierce Animals Are Rare*, 32. Chapter four of this text specifically addresses how the chain of energy, beginning with the collection of solar light energy in photosynthesis, harnessed by plant life cycles to animal life.
[92] Hegel, *Philosophy of Nature*, 352.

upon the prior, creating numerous levels of mediation, until finally a being emerges which is capable of expressing true freedom.

According to the structure of Hegel's *Philosophy of Nature*, it is in the mediation achieved through plant life that provides animal life the freedom and mobility which defines it. As animal life becomes more and more complex, so too does it achieve higher states of freedom. Consciousness, perception, and awareness are also developed to higher and higher levels. As they become more advanced they eventually lead to the human being: the self-conscious animal, the harbinger of Spirit, and the embodiment of the abstract Idea coming to know itself. Animal life culminates in the human being, who in turn is completed by Spirit. With this completion the Idea comes full circle. As stated earlier, human mental development can be viewed, not only as the vertex of nature's development, but also as the fulfillment of the Idea finally coming to complete its externalized rational potential by comprehending itself in all things.

This expression of pure freedom, as the result of mediation and separation from physical nature, may in fact explain the human disconnect to the physical world. As human beings become more and more removed (free) from nature, it is no longer treated as the source of life, but as a means to it. Only a small theoretical push is needed, and provided by the subject/object abstraction, to reduce all nature to base matter. Expressions of greater levels of freedom *from* the natural world likewise correspond to a greater disconnection from nature. We can see how in the context of Hegel's system this separation is required to advance human consciousness. The process remains unfinished, however, because division cannot be maintained. Therefore reconciliation is desired—or rather necessary, as necessary as the initial division itself—to overcome this disconnect.

The self-knowledge and understanding that the human being achieves is accomplished by the working over of the natural world through the actualization of our concepts (i.e. praxis). This aspect of the human/nature relationship holds a unique problem (which will also be discussed in the final section of this chapter). As mentioned in chapter two, self-knowledge is achieved for the human being by actualizing thought (that is, by determining concepts) in the world. This requires that the natural world be worked over and altered by human will, allowing human beings to then reflect on their concept realized in the world. Just as plant life fits into its environment while also reconstructing its environment to suit its needs, so too is animal life both constructed by and actively constructing its environment. The level of freedom available to human beings permits an unparalleled ability to actively construct the natural environment.[93]

The human being is the unique animal that Hegel considers the zenith of natural development. Its uniqueness is a result of its possession of a self-conscious mind which is capable of comprehending the Idea. It is through work and action that the process of mental development is completed. Here we can see the rational for Hegel's claim that we must unify the subject/object division because both work intimately and symbiotically to create conscious awareness. Reflecting our actions back to us and causing conceptual growth and reflection is the role of nature in conscious mental development.

Hegel's *Philosophy of Nature* is a defining theory of nature which I argue can be seen in most all subsequent natural philosophies. Despite being criticized for outdated scientific facts, it has powerful implications for our modern treatment of nature through our technological society. Like all thinkers, including scientific thinkers, Hegel is a child of his time. Hegel rarely strays from the findings of empirical science. The one point which is the main source of contention

[93] See the discussion of Horkheimer and the human desire for the "unrestricted fulfillment" of our freedom from necessity for an elaboration of this point in chapter 5, section β.

between Hegel and the empirical sciences is that rather than explain natural phenomena only through external factors, Hegel instead offers an account of development as having an intrinsic rationality which is teleologically necessary and unfolds logically.

As stated earlier, Hegel claims that there is a force or impetus in nature which compels it to rationally overcome contradictions.[94] Regarding this point, Alison Stone claims: "Hegel's idea that empirical science presupposes a metaphysical conception of natural forms as bare things reformulates the familiar view that modern science "disenchants" the natural world, denuding nature of the spiritual meaning...and reinterpreting it as intrinsically meaningless and valueless."[95] Here we have Hegel, nearly one hundred years before Weber, critiquing the metaphysical premises of modern sciences which allow for it to disenchant the world.[96] While Hegel may well have been critical about parts of modernity that he saw as metaphysically insufficient, he was thoroughly committed to the modernist project. Hegel's project is itself a forward moving attempt to synthesize the modern notion of rationality with the intentionality of nature. The seed of critique that is taken up later by other thinkers, specifically theorists of the Frankfurt School, can be seen in its nascent form in the theory of nature and development set out by Hegel.

Nature as Conscious Intentionality: From Critique to Renewal

> Nature is man's *inorganic* body—nature, that is, in so far as it is not itself the human body. Man *lives* on nature—means that nature is his *body*, with which he must remain in constant intercourse if he is not to die. That man's physical and spiritual life is linked to nature means simply that nature is linked to itself, for man is part of nature.[97]

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[94] Stone, *Petrified Intelligence*, 65.
[95] Stone, *Petrified Intelligence*, 71.
[96] Weber, "Science as a Vocation." This lecture was originally published as a text in 1919. See also my discussion of Weber in Chapter 5, section γ.
[97] Marx, "Economic and Philosophic Manuscripts," 75.

There are two main critiques leveled at Hegel that now need to be addressed. The first set of criticisms I will call "historical" as they focus on Hegel's historically limited knowledge of the natural sciences. The second critique will be the final critique that I address and also the one that holds the most relevance for us today. I will designate this second critique as the "contemporary critique" to distinguish it from the former, as well as to indicate its current relevance. The historical critique which has been the source of much of the rejection of Hegel's *Philosophy of Nature* is threefold. It consists of Hegel's use of the outdated science of his time, his combativeness toward Newtonian Physics, and this rejection of the theory of evolution as it existed in his time. The first component of the historical critique was dealt with briefly in the last chapter, but I will revisit it now. Hegel, like all of us, was limited not only to the knowledge, but also to the science, of his time. It would be unfair then to attack his *Philosophy of Nature* strictly on historically scientific grounds. This would be the equivalent to criticizing Aristotle for asserting the fixity of celestial spheres while using the lunar landing as the counter argument. While it is true that much of the scientific data that Hegel utilizes in his *Philosophy of Nature* has been replaced, the philosophical argument that Hegel presents is still timely and relevant.

Hegel's rejection of Newtonian physics on the other hand has a deeper motivation. Hegel sees Newton as a mechanistically reductionist thinker, and takes an "anti-reductionist" stance against him.[98] As Thomas Posch claims: "A mechanistic worldview can be characterized by its failure to adequately grasp the idea of a *system* due to an inherent tendency to reduce a given whole to a mere *sum* of its parts."[99] From what we know about Hegel, it comes as no surprise that he would be fundamentally opposed to such a world view. It seems that Hegel is not attacking the advances made by Newton in the field of physics. Rather, Hegel is opposed to

[98] Posch, "Hegel's Criticism of Newton's Physics: A Reconsideration," 6.
[99] Posch, "Hegel's Anti-Reductionism," 64.

Newton's metaphysical assumption, that is, his reductive mechanistic world view. This world view sees all of natural phenomena as mathematically structured. Hegel's critique is not to refute this view of phenomena, but rather to suggest that it is only one way by which to consider phenomena. Phenomena, according to Hegel, should not be limited to a strictly mathematical understanding. Hegel does approve of mathematical models of nature. However, what he is opposed to is the reduction advocated by some thinkers, in this case Newton, to "put everything on the same level."[100]

What Hegel proposes instead is that philosophy is capable of offering the counter position to a mechanistic world view and can grasp the system of nature in a way that accounts for all of the parts without reducing all of nature to base mathematized entities. As Edward Halper states: "Since Hegel thinks that philosophy proceeds by finding and overcoming contradictions, his claim that Newtonian mechanics is contradictory does not imply that it is worthless, as we might suppose; but he does think…that his a priori science, the Philosophy of Nature, advances empirical science."[101] Hegel is not offering a rejection of Newtonian physics, but its sublation into a higher understanding of nature. Here Hegel seems to be anticipating Thomas Kuhn in suggesting that paradigms of science go through revolutions.[102] Hegel's critique, that a reductive understanding of nature is contradictory, supports my claim that the advances in technology we are experiencing in biomimicry are in fact reflective of a larger shift in human knowledge that is seeking a more systematic understanding of nature. Therefore, that which has been the source of much of the ridicule of Hegel's *Philosophy of Nature* by natural

[100] Posch, "Hegel's Criticism of Newton's Physics: A Reconsideration," 10.
[101] Halper, "Hegel's Criticism of Newton," 313.
[102] Pinkard, "Speculative Naturphilosophie and the Development of the Empirical Sciences," 19.

scientists, that is, his critique of Newton, appears to hold a good deal of value for contemporary critiques of reductionist (one can even say instrumentalist) world views of natural phenomena.

The final component of the historical critique of Hegel's natural system is his stated rejection of the theory of evolution. Any careful reader of Hegel will concede that his *Philosophy of Nature* appears to be setting out a cosmology in line with evolutionary theory. The theory of evolution that Hegel was familiar with was different from the theory of Darwinism that we typically associate with evolution. Darwinian evolution comes closer to representing this teleology while also demonstrating a historical development and division of species over time. Hegel's reaction against the theory of evolution of his time is that it was not teleological and showed no necessary progression from one advance of nature to the next, while also maintaining the particularity of the individual species in their own right. J. N. Findlay in the forward to his translation of the *Philosophy of Nature* clearly presents the issue surrounding Hegel's position on evolution.

> Hegel…thought it false and, worse than false, philosophically irrelevant and misleading, to temporalize Nature in its notional stages into a temporally arranged evolutionary picture. The natural stages in question were all logically necessary to the existence of Nature as a facet of the self-explanatory Absolute, and it did not make their serial order more intelligible to imagine them as following on one another in time…But as Hegel was willing to temporalize the spiritual history of Man, without denying the living totality of the present, it is not clear why he was not prepared to do the same for Nature.[103]

Findlay addresses the central concern over Hegel's rejection of evolution. Can we temporalize nature while also retaining the teleological necessity of its development, thereby uniting Hegel's view of natural progression with an evolutionary account?

[103] Findlay, Forward to Hegel's *Philosophy of Nature*, xv.

John Burbidge claims that Darwin may have provided the negative element to evolutionary theory that was missing in Hegel's day.[104] Darwin addressed the contradiction within the concept of evolution that prevented Hegel from accepting it as it was in his day. Craig Matarrese suggests that more recent developments in evolutionary theory work to support Hegel's teleological account of nature's progression. "Contemporary interpretations of convergent evolution seem to be the sort of account Hegel was looking for, because they are clearly dependent on an *a priori* explanation of the functional exigencies that generate similar adaptations in otherwise independent populations of organisms."[105] Evaluating Hegel's *Philosophy of Nature* in relation to contemporary theories of evolution may provide the necessary sublation of his thought with what he saw as a contradictory theory of development. Despite the debate surrounding this issue, I suggest that Hegel's *Philosophy of Nature* is best read and understood from the position that Errol Harris elaborates:

> [T]he true Hegelian concept of nature is…of a world, in every detail of which mind is imminent and throughout which mind comes to consciousness in and by means of a process of self-evolution…[and] the evolutionary process goes through numerous phases which constitute the range of existing things in the material world, eventually bringing mind, which has been immanent all along, to consciousness of itself.[106]

Harris' position demonstrates the role of mind as the essence of all things and the teleology of development, while also accounting for an evolutionary and historical development of natural entities.

The next criticism that I intend to focus on is the "contemporary critique" and has to do with the concept of labor in relation to Hegel's theory of nature. Hegel maintains that nature must be worked over for two reasons. The first reason is in order for human beings to actualize

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[104] Burbidge, "New Directions in Hegel's Philosophy of Nature," 184-185.
[105] Matarrese, "Starting with Hegel," 91.
[106] Harris, "The Philosophy of Nature in Hegel's System," 219. Brackets mine.

their concepts. That is, so that human beings can see their mind externalized, realized, and made material in the physical world. The second reason is so human beings can reflect on their materialized thought, thereby coming to greater understanding of both themselves and the world. The necessary relationship that human beings have with the natural world for Hegel is that of manipulating and altering it for the purpose of Mind coming to know itself. It is at this point, and in the conflicting relationships that emerge from it, that we can see the necessary connection that the mind and nature have to one another through human labor.

However, this necessary characteristic of self-knowledge poses it own unique problem. The issue then becomes: By working over nature, human beings are altering—and in many cases outright destroying—nature. How then can we continue to labor and transform the world ethically and without completely destroying it? A sympathetic reading of Hegel suggests that his failure to recognize and describe the limits of nature reflects not a failure in his thinking, but rather the limited understanding during his time of the world's resources as limitless. Just as Hegel sees the externalities of capitalism as capable of forever being displaced, so too is the destruction of nature caused by human labor incapable of inflicting permanent damage.[107] This stance is not an endorsement of the scientific understanding but rather a historical contention unquestioned by Hegel. I suggest that only now with our contemporary knowledge of a limited, constricted, globalized world are we capable of comprehending the limits of nature and anthropomorphic environmental degradation.

[107] Despite what some would have us think about the consequences of capitalism, the environmental impact of development cannot be dissimulated. Just as the contradiction of capitalism unexpressed by Hegel cannot go overlooked by Marx (who sees its resolution as inevitable), so to can the environmental impact of such a system of production and exchange not be overlooked.

Responding to this challenge, Alison Stone suggests that there is an environmental ethics at work in Hegel's *Philosophy of Nature* that concerns the value, intrinsic, that Hegel's philosophy places on nature which modern science does not. Her critique of Hegel revolves around his notion of labor and his lack of elaborating what this action entails for our relationship to nature. For Hegel, all of nature is essentially good. Along with being intrinsically good, nature also embodies the metaphysical Idea. The duty that faces human beings is that they must work over, mold, and transform nature to make their conceptual Ideas a reality. The final result for Hegel is the shift from human beings molding and coercing nature to reflect their individual or collective Idea to the recognition that the Idea already pervades all things. The duty for human beings is to make the Idea that pervades all things explicit.

Stone claims that Hegel would not approve of destructive practices that irreconcilably damage the natural world. She states:

> When humans modify entities at a sufficiently deep and irrevocable level, then, they are acting irrationally…by [Hegel's] own standards, certain ways of transforming nature are irrational, so, given his belief in human's duty to remove irrationalities, he should affirm the need for transformative duties to become *restricted* by an addition set of *preservation* duties.[108]

Working from Hegel's premise that all things are not only united by the Idea but also unconditionally interconnected, Stone argues that any destructive practice would appear to Hegel as irrational and therefore contradictory. As we have already seen, any contradictory relationship must necessarily be worked through to resolution. Stone suggests that this contradiction is implicit to Hegel's system, yet never made explicit. Like Marx who saw the contradiction in capitalism that directly conflicted with Hegel's social and political philosophy, Stone is

[108] Alison, "The Ethical Implications of Hegel's Philosophy of Nature," 27.

identifying the contradiction in the human relationship to nature that is left unexpressed by Hegel.

In Hegel's analysis of the relationship of Lordship and Bondsman, Lord's must limit their freedom and recognize the other to establish a mutually advancing relationship. So too must human freedom assume the duty of preservation and a mutual relationship to nature allowing it to advance from a dominant relationship to one of emancipation. Stone argues for the restriction of human freedom by "duties of preservation." However, the mutual relationship enjoys another, and perhaps more important, occurrence. Engaging in a mutual relationship to the natural world edifies humanity and moves its thinking of the world and itself forward. As human thought progresses, so too will technologies being themselves the direct product of the mind. This self-developing moment advances human thought and technologies. What this argument shows is the dynamic at play between human thought and practice with the natural world.

As was mentioned in the second section of chapter two, Hegel claims that Absolute Knowing is the true understanding of the world and ourselves. This understanding can be achieved in various forms such as law, art, religion, philosophy, etc. I would expand on Hegel's claim and suggest that a true knowledge of the world can also be achieved through the human art of technology. This is not to suggest technological utopianism. Rather, I posit that as technology develops and we reflect on both its benefits and consequences, that it is capable of aligning us closer with a true knowledge of reality.

CHAPTER 4

PIAGET AND DIALECTIC

As we saw in the last two chapters, Hegel sets forth a theory of development that is systematic and dialectical. His theory of mind remained abstract until developmental psychology took it up later within a specialized discipline. Through investigative experimentations, developmental psychology began to account for mental development in a dialectical way. The developments of psychology, specifically theories of mental development, are a testament to Hegel and demonstrate only a portion of his vast influence on systems of knowledge. The first section of this chapter will begin with an outline of the crisis facing modern psychology, which I argue lead it to embrace new theories, specifically theories of dialectical development. This crisis is made explicit through my examination of the work of Edmund Husserl.

In the second section, I move onto an evaluation of Jean Piaget's dialectical theory of human mental development. I suggest that not only is Piaget's theory thoroughly dialectical, but that it shares numerous similarities with the theory set forth by Hegel. Piaget sets forth a dialectical theory of mental development grounded in experimental data. It is after positing a theory of mental development as dialectical that both Hegel (as shown in chapter two) and Piaget are led to shift their focus from mental development to the natural world.

In the final section I will turn to Piaget's biological theory of development. I demonstrate how the basic mechanisms at work in his theory of mind likewise function in his theory of organic development. Specific to his theory is the concept of equilibration and the logical intention present in nature towards life, survival, and production. The main difference between these two theories of nature resides mainly in terminology and the presence of the scientific data historically available to each thinker. In short, I argue in this chapter that there is a common

assumption shared by both Hegel and Piaget, that development is dialectical. Furthermore this dialectic is at work in all stages and at all levels of development, both physical and mental. Therefore, both thinkers set out the possibility for biomimicry's philosophical foundation.

Psychology is a Specialized Discipline, Human Development is Not

One result of the modern epistemic shift is a focus on the specialization of knowledge. This practice is a result of what Hegel referred to as the analytical power of the Understanding. It is essentially the ability to break down all the features of both knowledge and the natural world into component parts, which are then capable of being categorized and analyzed. Hegel criticizes this approach to knowledge, which constitutes the mind as an instrument that human beings aim or direct towards experience for the "uncovering" of truth. For Hegel Mind, society, and experiential reality (the natural world) are in fact one process in perpetual dialogue with itself. This stance is explained in the beginning sections of Hegel's introduction to the Phenomenology. Here he elaborates on the failure of any attempt of "…an *understanding* of cognition, which is regarded either as the instrument to get hold of the Absolute, or as the medium through which one discovers it."[109] What Hegel proposes instead is dialectical *comprehension* capable of overcoming and uniting all things and thoughts conceptually.

Psychology is just one example of a specialized discipline of human knowledge. What is the object it studies? How has it been traditionally treated and what has been the traditional approach to studying it? These questions underlie the true significance of psychology's project. This project is the return to the preliminary inquiry that birthed a progeny of specialized disciplines, as well as specialized answers. Psychology is, in its essence, the compartmentalization of the philosophical problem of questioning into how the mind works,

[109] Hegel, *Phenomenology of Spirit*, 46. Emphasis mine.

develops, applies itself to solve problems, acts in the world, and most importantly comes to acquire new knowledge. This is a project as old as historical time. It is made transparent by the Kantian problematic of how an instrument (the human mind) can come to critique and comprehend *itself* truly. In other words, it is the problem of whether or not our minds are capable of questioning and knowing the origin of mental development and its own coming to be.

Psychology as a field of research gained a powerful new tool of inquiry through the development and success of the modern sciences with their systematic analytic treatment of the natural world. After witnessing the successes of formal logic in the natural sciences, psychology was quick to take up these methods as investigative tools for knowledge. Psychology, specifically as a specialized field of knowledge, submits to the modern form of analytic thought. Analytic thought (or formal logic) seeks to know truths about the world by reducing it to its component features and abstracting formal systems by which to understand the interaction of these features. It is this method of thought that perpetuates instrumental rationality allowing it to permeate into all forms of knowledge about self and reality. Revolution within this specialized field will come not from insights and innovations from within it—that is, from a more thorough analytic disassembly and categorization—but from the discovery and acceptance of innovation from its history and interrelatedness to all other specialized fields of inquiry. Innovation and progression in psychology can only come through a dialectical (re)cognition of the wholeness involved not only in its own project, but in all inquiries into knowledge.

The embrace of formal analytical logic led to a crisis in the sciences. Such a crisis of the sciences is most clearly expressed in the crisis of the psychological sciences. This crisis, outlined by Husserl, still appears to be with us. It remains with us due to the fact that the metaphysics of the modern subject is still the dominant episteme in our time. As Husserl argues, the crisis of

psychology emerges from the metaphysics of modern philosophy, and is reflective of the larger crisis of the modern sciences as well as that of subjectivity itself. What then is the crisis of the modern sciences? This crisis, as Husserl suggests, is the scientific reduction of life to an object and its subsequent loss of meaning.[110] The Enlightenment gave birth to powerful and wonderful ideas, such as the concepts of rationality, freedom, and autonomy. However, every intellectual concept is founded on premises. The Enlightenment's overriding premise was the modern notion of subjectivity. Abstraction and objectification of the human subject, as the result of the modern epistemology and its extension of the objectification of the natural world to the human being itself, has implications for all aspects of existence. One example of this, as we examined in chapter one, lies in the successes of the natural sciences being questioned thoroughly for leading to a destructive (and more specifically a self-destructive) approach to the natural world.

This crisis emerges in the intellectual tension of the modern sciences and conceived of problems of mind so foundational that it in turn demanded new theories to reconcile this conflict with itself. These theories—which struggled to traverse the objective method of modern science and the seemingly inherent truth of the individual subjective position—attempted to understand the human mental subject, its relation to the world and other people in the most fundamental way possible.[111] Just as with any form of development—either intellectual or physical—tension is necessarily required for progress. This productive tension, which is the direct result of the modern epoch, is what I intend to explore.

The crisis that faces psychology is a crisis inherited from modern philosophy. More specifically it results directly from the aftermath of Cartesian dualism. Mind/body dualism is a

[110] See here the relationship of Husserl to Heidegger as suggested by the translator David Carr (see footnotes: Husserl, *The Crisis of the European Sciences*, 5,8, & 12).
[111] As we saw in the last chapter, Hegel worked thoroughly to make this approach explicit.

necessary requirement for modern sciences' successful investigative practices. It was this conceptual shift that Hegel claimed severed form from content. Modern science stands nature up, objectifying it in every way possible, in order to gain a rational and totalizing system of knowledge. This process eventually entered into the realm of psychology and the human relationship to consciousness itself. However, because modern science is predicated in this dualism, when contradictions do emerge concerning the mind/body relation it does not appear to be a problem concerning the position of dualism itself. Rather, what is required to circumvent this problem is a psychology that further reflects and mimics the empirical sciences objectifying the human subject to the point of base material knowledge. Such a solution subsequently fails to reexamine the dualist position it is predicated on in order to achieve what appears to it to be a more comprehensive understanding of mental phenomena. In other words, analytical understanding holds onto what it knows and continues to systematically break apart and examine without questioning the abstracting bifurcation which allows for this capacity in the first place.

The Cartesian subject, as modified by Kant to address the arising problems of certainty and transcendent authority, is the metaphysical underpinning for all modern sciences. When this subject is questioned or found lacking, so too are the metaphysic principles of the sciences founded upon it. Subsequently a crisis emerges.[112] Husserl elaborates on this crisis:

> …we shall soon become aware that the difficulty which has plagued psychology, not just in our time but for centuries—its own peculiar "crisis"—has a central significance both for the appearance of puzzling, insoluble obscurities in modern, even mathematical sciences and, in connection with that, for the emergence of a set of world-enigmas which were unknown to earlier times. They all lead back to the *enigma of subjectivity* and are thus inseparably bound to the enigma of psychological subject matter and method.[113]

[112] Husserl, *The Crisis of the European Sciences*, 11.
[113] Husserl, *The Crisis of the European Sciences*, 5.

In the center of the crisis is the lack or loss of meaning that emerges from the modern subject and how it is treated in relation to a scientific understanding of the world. Modern sciences are totalizing in their objectification of the human being. As this objectified worldview emerges, so too does an emptied and nihilistic self-understanding. This results from the modern sciences inability to provide answers to humanity's search for meaning. This extreme objectification of the human subject is the cause of the crisis.[114]

The modern subject—complete with the transcendental ego—does not represent a completed process in the history of thought, but rather an ongoing process that is continually carried out by current thinkers. Out of this new self-knowledge come new forms of science (that seek to understand both the objectified world and the inner world of the mind) grounded on this dualism. The main problem with this development of self-knowledge is that this subjective philosophical basis is predicated on a contradiction that develops from dualistic self-understanding. Hegel argued, as was shown in the last chapter, that so long as a division exists reason cannot rest until this separation is resolved. The division of the mind/body, which is also the basis for much of modern thought, is such a separation. I suggest that much of philosophy—and many of the problems that emerge out of specialized disciplines of knowledge—is constantly struggling with this division and is actively seeking its reconciliation.

Such a struggle displays itself in the relation of psychology to all other sciences. Psychology is a science of mind; however, it is radically different from other "objective" physical sciences. This results because its object (or subject) of inquiry belongs to that historically new and strange transcendental subjectivity. This "phenomena" of inquiry is

[114] As we will see in the discussion of Weber in chapter 5, this crisis becomes central to the human understanding. As a result of it, the enlightenment represents not so much a new knowledge of the world but instead the world's disenchantment and loss of meaning.

precisely non-physical, non-material mind. The result of this difference between the sciences in the object of their inquiry is the aforementioned crisis. Crisis or tension arises between the physical sciences and the human sciences when the former's model of investigative practice fails to provide knowledge for the latter due to a fundamental difference in the subject under investigation.[115]

Husserl argues that phenomenology is capable of merging and sublating the two thereby overcoming this crisis. Overcoming this crisis is essential because it permeates into all our systems of knowledge. Husserl also wants to maintain a standard for judgment and not reduce the world to the realm of subjective relativity. This standard he claims is reason. Husserl concedes that not only did reason place us in this crisis, but it also has the capacity to pull us back out. Husserl suggests a resolution—in the form of a new phenomenological ground to science—involving a reevaluation of the philosophical premises underpinning both the modern subject and the modern sciences.[116] Like Hegel, this reevaluation will be compelled to consider the human subject as it exists in dialectical relations with both other human beings as well as the natural world. In other words, a new whole systems approach is needed for the creation of an accurate theory of human mental development. I suggest that such an approach is provided by Jean Piaget.

Piaget's Project: Dialectics and Coming Full Circle in Human Development

Jean Piaget begins his theory by delineating the development of structures of knowledge through a phenomenological basis. His stated research goal is similar to Kant. He is seeking out a ground for knowledge. From this epistemological inquiry, he sets out a unique theory of development which incorporates physical, mental, and biological progression. Not only is his

[115] Husserl, *The Crisis of the European Sciences*, 212, 223.
[116] Husserl, *The Crisis of the European Sciences*, 216.

starting point phenomenological, but the processes of mental development that he theorizes are dialectical. As he states: "…knowledge does not start in the subject (through somatic knowledge or introspection) or in the object (for perception itself contains a considerable amount of organization), but rather in interactions between subject and object…"[117] Piaget's dialectical account of knowledge formation corresponds nicely to Hegel's theory of the dialectical development of consciousness. This development evolves from the subject's activity and engagement with the physical environment. Piaget also notes that not only does mental development rely on environmental influence, but this development itself is subject to and directed by environmental influences. Piaget positions himself away from behaviorism or a mechanistic perspective, yet he does allow for environmental influence in mental development. According to Piaget there are two elements of facticity that influence mental growth. The first are the hereditary factors of the individual; the second factor is the external environment.

Hereditary factors are vital in allowing the subject not only the ability to engage with the world, but also in providing the abilities to understand it. Piaget suggests that there are two groups of hereditary factors in individuals that work to formulate intelligence. The first he calls structural. These are physical hereditary factors, which permit sensory perception and mental processing. This group includes sensory organs, and the physical mental apparatus. The second group consists of mental heredity factors and concerns thought or ideas. It is in this group that we find the capacity for reason, conceptualization, deduction, generalization, and the mental organization of reality that is characteristic of intelligence. The processes of this second group are unlimited. This separates them from the former group which is limited both in its capacity and ability. For Piaget, once the hypothetical-deductive stage is reached, knowledge acquisition

[117] Piaget, *Biology and Knowledge*, 27-28.

continues, but human mental development is concluded. We can see here how physical hereditary factors may complete and exhaust their development without limiting the ability of mental hereditary factors to continue to grow unrestricted. This suggests that mental processing never reaches a terminus when properly stimulated and applied. For Piaget there is no stage of human mental development beyond this final stage.

Hereditary factors are what the subject brings to intellectual development; however, intellectual development is not complete without another and equally important element. The external environment (or phenomenal world) provides the corresponding half of the dynamic relationship that comprises human intellectual development. Piaget claims: "There can be no doubt either, that mental life is also accommodation to the environment."[118] The fulfillment of intellectual development is completed with the individual's activity and engagement with the external environment. Knowledge is not only necessitated on this interaction, it requires accommodation to the environment for its very development.

Piaget maintains that the dialectical nature of human mental development is definitive of developmental growth in general (and to the functioning of the universe itself). He claims:

> …contrary to unorganized beings which are also in equilibration with the universe but which do not assimilate the environment to themselves, it can be said that the living being assimilates to himself the whole universe, at the same time that he accommodates himself to it, since all the movements of every kind which characterize his actions and reactions with respect to things are regulated in a cycle delineated by his own organization as well as by the nature of the external objects.[119]

Piaget echoes Hegel here to a great extent. Human beings, and the natural world itself, are in a reciprocating process of dialectical development. Human beings have a unique position in that

[118] Piaget, *The Origins of Intelligence in Children*, 6.
[119] Piaget, *The Origins of Intelligence in Children*, 407-408.

we are the only form of life we know of that both assimilates the whole universe into itself, and also accommodates or melds itself to the universe (the external environment).

Assimilation, the process whereby new experience is categorized and explained within existing cognitive structures, when applied to organic development is shown to be how an organism interacts and internalizes its external environment into its (the animal's) existing form. For example, the assimilation of soil nutrients, sunlight, and water by the cape aloe vera plant *Aloe ferox*, while not only creating environmental alterations to its habitat to suit its existence, serves to regulate is growth and continued existence. Assimilation holds a double value for Piaget. He suggests that it is important for both the development of meaning and the connection of action to cognition. It is only out of action—which is itself dependent on assimilation—that knowledge emerges.[120]

Accommodation, the process whereby cognitive knowledge structures are altered to accommodate or account for new experiential input, when applied to organic development demonstrates how an organism physically adapts or accommodates its form to its physical environment. For example the change in the physical structure of the species *Aloe ferox* has allowed for it to develop leaves that protect it from fires, displaying a direct accommodation to its environment.[121] These concepts function to achieve equilibration, which Piaget sees as the central component and guiding force of autoregulation.

Like Hegel, Piaget also holds that this dialectical development occurs not only for intellectual development, but for all biological development as well.[122] This point will be discussed in greater detail in the following chapter. However, one central difference does exist

[120] Piaget, *Biology and Knowledge*, 5.
[121] See chapter I section α.
[122] Piaget, *The Origins of Intelligence in Children*, 1.

between Piaget and Hegel. Piaget never completely sublates the relationship between the body and mind, nor the relation between the mind and world. This lack of synthesis is a fundamental difference between the thinkers. For Piaget, the subject does not become substance as it does for Hegel at the end of the *Phenomenology*.

For Piaget, dialectic functions in a similar fashion to that of Hegel. One difference is that the component movements are renamed. Concerning intellectual development, the initial impetus is need (recall that for Hegel the motivating impetus is called desire). Need forces or moves the subject to seek fulfillment on some level. Need is the force which motivates and "defines life itself" for Piaget.

> …all needs depend, either immediately or remotely, upon a fundamental need which is that of the organisms development: Assimilation. It is due to the subordination of the organs to this chief tendency – *which defines life itself* – that the function of each one gives rise to a particular need… The need sets in motion the act and its functioning, but this functioning itself engenders a greater need which from the very first goes beyond the pure satisfaction of the initial need.[123]

Need, or what Hegel recognizes as desire, is a type of negation. As we negate to fulfill needs, we both engage in dialectic as well as perpetuate our existence. The subject assimilates reality and there is a correspondence to the world based on the subjects need. Reality is aligned and matches experiences in the world. However, the subject cannot remain in this state of affairs because it is static, and leads to stagnation. Also the world itself will not allow for inactivity. It therefore prompts the subject through experiential contradiction—or in Piaget's terminology, disequilibrium. Once contradiction and disequilibrium occur, the subject must perform an accommodation to this new aspect of reality. This new cognitive structure allows for adaptation. Then again, a new correspondence to reality emerges that takes into account the contradiction,

[123] Piaget, *The Origins of Intelligence in Children*, 170. Italics mine.

and allows for a new level of assimilation. With this, equilibrium is reached between the subject and the environment.

According to Piaget, as knowledge structures develop they come into contact with objects of experience. If the structure is insufficient in any way at explaining experiences in the world, it enters into a state of disequilibrium. Equilibration occurs when either the structure for understanding is altered to create a new account or knowledge of experience, or the object of experience is understood in a new way within the current knowledge structure. The former Piaget calls accommodation, in that the structure of knowledge accommodates new information, experiences, and objects. This is the true dialectical moment for Piaget, where a new experience forces development. The later he calls assimilation, in that our mind or structures of knowledge assimilate, i.e. simply take in new input.[124]

[124] This concept is similar to Deleuze's concept of recognition whereby an individual is simply recalling or (re)cognizing, and experience does not radically alter the knowledge structure. He sees nearly every philosophical investigation in the western tradition as being predicated on a philosophy of identity or recognition. This is a failure on the part of thinkers to 'recognize' that thinking is in fact grounded in difference. There is then a bifurcation between what thinking is and what thinking is perceived or recognized to be. Deleuze suggests that thinking takes place in difference and in the form of an encounter, and that what has been typically conceived of as thought takes place in identification and in the form of recognition. He claims that there are, "… two kinds of things: those which do not disturb thought and…those which *force* us to think. The first are objects of recognition: thought and all its faculties may be fully employed therein, thought may busy itself thereby, but such employment and such activity have nothing to do with thinking. Thought is thereby filled with no more than an image of itself, one in which it recognizes things..." *Difference and Repetition*, 138. Deleuze designates thinkers of recognition—those who fully employ the faculties of thought within identity and recognition, however genius their conclusions and abilities may be—as "philosophical labourers because their philosophy remains marked by this indelible model of recognition." *Difference and Repetition*, 136. In his understanding, individuals can work within the realm of habit, producing new concepts and ideas. However, this is not thinking proper. It is a form of concept-making that does not provide knowledge. Deleuze has a very specific definition of knowledge. He states: "Learning is only the intermediary between non-knowledge and knowledge, the living passage from one to the other. We may well say that learning is, after all, an infinite task..." *Difference and Repetition*, 166. Knowledge then is a perpetual process: There are no such things as errors,

In the early stages of development, progress is most clearly linked directly to the interaction of the human subject with the objects of experience (be they material things or other human subjects). This description of development shows Piaget's experiential/phenomenological starting point.[125] When elaborating these early stages of development, Piaget appears very Hegelian. This would be clear to any reader of Hegel who sees how he has linked the development of western thought to the development of consciousness. Piaget's project is similar in that it appears at first glance to be tracing the Hegelian development of self-consciousness and cognition in the observable development of the mental life of a child. Indeed this would be an exciting project: To take Hegel's unfolding development of self-consciousness in the history of human culture and apply it to the empirical history of the development of self-consciousness in the child. Piaget does not however take the next Hegelian step in bringing development to a point where form and content collapse, and the subject becomes substance. He advocates instead a conceptual abstraction, defined by formal mathematical logic, as the highest stage of development. For Piaget, the form that is achieved from the prior accommodation becomes the content for the next stage of development. There is never a point where the two unite as they do for Hegel.

The culminating stage of human cognitive development Piaget defines as formal operational. This stage represents a form of universal abstract logic. According to Piaget it is the apex of cognitive growth. Piaget describes this stage as the achievement of "adult logic."[126] What is achieved in this final stage is the complete abstraction of mental systems. It represents the full

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only moments of educational awareness—which allow us the possibility to move from non-knowledge to knowledge—and that we can either chose to recognize and learn from or not.

[125] Piaget, *Insights and Illusions*, 23.

[126] *The Essential Piaget*, 461.

separation of the subject from the object of experience, as well as the full removal of form from content. This division is the apex which all prior development has been working towards.

Both Hegel and Piaget are advocating a similar perspective of how life (both biological and intellectual) functions. This is not the only similarity that they share. In regards to the activity of the subject and its importance in development, both seem to be in agreement. In Piaget's view, action is demanded of the subject by the world. He states: "Perception is meaningless without some accompanying action."[127] It is what puts the process of life into motion. He also claims that action is twofold. On one hand there is what he calls "energetic or affective" action. This is action that is physical and engages with the environment. On the other hand, there is mental or theoretical action (Piaget calls this the "structural or cognitive aspect" of action). This is when an act concerns intelligence and thought. Like action taken in the world for the satiation of need, cognitive action functions in similar fashion. Concepts, ideas, and definitions are formulated, and then acted upon or tested. The activity of thought is essential to maintaining a balanced relationship to one's mental life and the reality of the environment.[128]

Just as Hegel is led to a unique understanding of the social environment and its influence on subject formation in the form of labor, so too does Piaget incorporate the element of praxis into his theory of development. Whatever idea is formed, position is taken, or material object constructed, the social aspect of consciousness always influences the subject, as well as any actualization initiated by the subject. For Hegel, coming to see this is a step toward Absolute Spirit. As Piaget argues, it is significant, but not quite so totalizing. Piaget suggests that the social has an influence on the mental development of the individual, albeit to a lesser extent than

[127] Piaget, *Biology and Knowledge*, 7.
[128] Piaget, *The Psychology of Intelligence*, 4, 33.

Hegel.[129] He claims: "Every relation between individuals (from two onwards) literally modifies them and therefore immediately constitutes a whole, so that the whole formed by society is not so much a thing, a being or a cause as a system of relations."[130] This system of relations represents another aspect of experience, which is paramount to the formation of knowledge. This is the much overlooked social aspect of Piaget's theory which is considered a component of the external environment. This social environment includes the induction of the individual into customs, laws, and the linguistic structure of a historical society. It factors just as much, if not more so, in the formation of the individual and their mental development as the natural world which serves to sustain them.

Piaget's adherence to a formal abstract logic reflects his Kantian assumptions.[131] Like Kant, Piaget recognizes that the dialectic is at work in mental development and knowledge formation. The hope for both thinkers is that there can be a universal ground to human knowledge. This seduction for the certainty given by analytics and abstraction is the major epistemological assumption of the modernist project. The problematic of this epistemological project results from its desire to limit and control knowledge systematically under the rubric of a mathematical abstract logic. Kant, Hegel, and Piaget are all working under and advancing this epistemology. This presupposition is not only directing their questioning, but directing their theories and determining their conclusions. However, the Hegelian moment is to recognize that this certainty attained by analytical understanding is never lost with the move to dialectical comprehension. For Kant and Piaget, the guiding assumption is that an abstract analytic rationality, grounded in mathematical formal logic and the law on non-contradiction, can

[129] Piaget, *The Psychology of Intelligence*. This idea is most clearly expressed in the chapter titled, "Social Factors in Intellectual Development."
[130] Piaget, *The Psychology of Intelligence*, 171-172.
[131] Piaget, *The Origins of Intelligence in Children*, 9. Or see: *The Essential Piaget*, 219.

successfully account for experience, reality, and the development of knowledge. Unfortunately, because this logic is based on a notion of identity that is construed conceptually in the human mind and not a foundational origin to all reality, it encounters systemic contradictions. What then is needed is an undivided comprehension of development as a perpetual process in constant flux; a process which is changing, historical, social, and therefore concrete.

The phrase "circle of the sciences" is a famous one of Piaget's and a guiding mantra that follows him though his entire life's work. It is also the driving force that leads his investigations of epistemology from psychology and logic to biology. He first expressed it in a semi-autobiographical novel that he wrote at the age of twenty.[132] By circle of the sciences, Piaget is suggesting that all the sciences draw from and advance within the same circle of knowledge. Conceiving of the sciences as composing a circle of knowledge is central to biomimicry's interdisciplinary premise. Biomimicry can look to multiple disciplines and sources for solutions and inspirations precisely because knowledge is a circle. This claim also serves to justify his goal of creating a united ground for all knowledge. My intention with this play on Piaget's famous phrase is to show how his Kantian project of seeking out and establishing a foundation on which knowledge can assure itself remains incomplete in that it still embraces the assumption of identity which creates the subject/object division. This conflict is expressed throughout all of Piaget's work. The way out of this circular science is a dialectical (re)cognition that the unity Piaget sees in the sciences applies to all things, including subject and object relations, physical development, and cognitive development. It is only by asserting the origin of the *inexhaustible difference of what is the same*, that there can exist the foundation for knowledge that Piaget seeks.

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[132] *The Essential Piaget*, 42.

A circular science is one which upholds an ideal concept by which to begin an inquiry and eventually justifies itself in its conclusions. Its method, subject of inquiry, and results are all influenced (if not outright determined) by its theoretical assumptions. David Bohm, the renowned physicist who not only advanced quantum physics but also advocated for an undivided conception of reality, makes the argument against such circularity in science most poignantly. Being guided by a fragmentary self-world view, man then acts in such a way as to try to break himself and the world up, so that all seems to correspond to his way of thinking. Man thus obtains an apparent proof of the correctness of his fragmentary self-world view though, of course, he overlooks the fact that it is he himself, acting according to his mode of thought, who had brought about the fragmentation that now seems to have an autonomous existence, independent of his will and of his desire.[133]

The regulative ideal that both Hegel and Piaget set forth for themselves is not a circular science, but rather a science of circles. This is perhaps best stated by Hegel:

> Each of the parts of philosophy is a philosophical whole, a circle rounded and complete in itself. In each of these parts, however, the philosophical Idea is found in a particular specificality or medium. The single circle, because it is a real totality, bursts through the limits imposed by its special medium, and gives rise to a wider circle. The whole of philosophy in this way resembles a circle of circles. The Idea appears in each single circle, but, at the same time, the whole Idea is constituted by the system of these peculiar phases, and each is a necessary member of the organization.[134]

Here the critique of Hegel and Piaget as being strictly circular thinkers holds little merit. These two thinkers are circular only in the sense that they attempt to work phenomenologically to point out the common force operating in the world to produce movement, development, and change. Finally after recognizing this force in all things, they make the claim that all sciences circle back

[133] Bohm, *Wholeness and the Implicate Order*, 2-3.
[134] Hegel, *Part One of the Encyclopedia of the Philosophical Sciences*, 20.

to this basic method of dialectical development. As Piaget claims: "…the more the [circle] is enlarged the more the observed convergencies allow us to find in this growing adherence the assurance that the circle is not vicious."[135] Rather than premise their thinking and investigations on a notion of identity and divisibility, these thinkers choose to begin their query by asserting undividedness to both reality and knowledge.

This coming full circle by psychology's investigation into the mind and development—regardless of any retreats that may have occurred in the discipline into formal logic, positivism, behaviorism, etc—leads back to Hegel and dialectics. After Piaget established his theory of human development, he turned to his original topic and interest: biology. Just like Hegel, he too put forth a theory of natural development that is both dialectical and which also corresponded to his theory of mental development. For both thinkers, mind, consciousness, organic reality, and everything that Piaget called "the fields of life" not only develops logically, but also exists interdependently within the circle.[136] The beauty and difficulty of both theorists is that they work within this circle, rather than exclusively partitioning off a segment of it to analyze. This is the true power of dialectical thinking. Cybernetics calls this process "parallel processing:" This is the ability to both synthesize and analyze information or data simultaneously.[137] Both thinkers attempt to provoke this form of thought in their readers through not only their use of terms, but also through their systematic engagement of subjects. Such an approach forces the reader to contemplate on multiple levels and in multiple ways. I would suggest that this method is the genius and difficulty of dialecticians. Having just presented both theorists' philosophies of mind, I intend to shift my examination to the other half of their

[135] Messerly, *Piaget's Concept of Evolution*, 59. Brackets mine.
[136] Piaget, "Jean Piaget; Autobiography," 242.
[137] See: Von Glasersfeld, "The Cybernetic Insights of Jean Piaget."

philosophical systems. The next section will present Piaget's philosophy of nature. I argue that his theory of natural development, just like his theory of mental development, share many similarities.

Philosophy of Nature in Piaget: The Metaphysics of Life[138]

Piaget began his research by investigating into the biological. He then shifted his thinking to epistemology and developmental theories of mind. After satisfying himself in this field, he returned to the biological, only now armed with the theoretical tools excavated in his earlier work. His resulting theory of natural development is a fluid extension of his theory of mind. He states: "The psychology of development has, by contrast, given an entirely different picture of the way in which knowledge and the intelligence are formed—a picture that makes us consider problems much closer to those major biological questions now under discussion…the reason being that all knowledge presupposes a physical structure."[139] We can see here two of Piaget's presuppositions. First, that knowledge is directly linked to the biological. Second, that both fields, the cognitive and the biological, therefore share similar systems and processes of development.

Whereas Hegel was not exposed to the evolutionary thinking of Darwin along with other advances in science that the twentieth century brought, Piaget on the other hand was most thoroughly.[140] Piaget himself admits to the newness and frailty of an evolutionary theory of

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[138] Vidal, *Piaget Before Piaget*, 43. Vidal claims, regarding Piaget's early interest in biological development that eventually led him to psychological development and back again, that: "The Inspiration for the radical changes that take place in Piaget's projects and worldview stating in 1912 is biological—but only in the sense that it originates in a philosophy of evolution and aims at applying to all processes a certain *metaphysics of life*." Emphasis mine.

[139] Piaget, *Biology and Knoweldge*, 2.

[140] In a letter to Marx not even thirty years after Hegel's death, Engels expresses reservation with Hegel's historical limit of scientific knowledge. However in keeping with the historical premise that guides both their theories, Engels suggests that Hegel would be able to draw more

development regardless of the advances in scientific theory made in the one hundred plus years between Hegel's work and that of his own. Concerning this point he claims: "Now, as everybody knows, this notion [of evolution] is of comparatively recent development in the history of biology, and it has taken a lengthy process of thought for us to graduate from the idea of a fixed state to evolutionism."[141] However, according to Piaget, it is only recently that we have allowed ourselves to relinquish the restraints of rigidity surrounding developmental processes and embrace a changeable theory like evolution. I intend to demonstrate in this section that Piaget's work done alongside his research into human development in the field of natural development and biology sets forth a natural philosophy that both supports and expands Hegel's *Philosophy of Nature*.

I being by presenting Piaget's theory of natural development and show its remarkable similarity to his theory of mind. Next, I explore the relations of the sciences and systems of knowledge to natural development. Piaget suggests that they play different yet essential roles in development.[142] Finally, I intend to examine some of the similarities his biological theory shares with Hegel's philosophy of nature. There is, however, a major and essential difference between Hegel's philosophy of nature and Piaget's theory of biological development. Piaget is not providing a cosmology or attempting to give an account of the exact historical progression of

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theoretical support for his theory from these scientific advances. Engels writes: "Kindly let me have Hegel's *Philosophy of Nature* as promised. I am presently doing a little physiology which I shall combine with comparative anatomy. Here one comes upon highly speculative things, all of which, however, have only recently been discovered; I am exceedingly curious to see whether the old man may not already have had some inkling of them. This much is certain: were he today to write a *Philosophy of Nature*, subjects would come flocking in on him from all directions." "Marx Engels Correspondence 1858," in *Marx Engels Collected Works*, 325.

[141] Piaget, *Biology and Knowledge*, 75. Brackets mine.

[142] I will be drawing heavily from John G. Messerly's text, *Piaget's Concept of Evolution*. Not only does Messerly present a great systematic view of Piaget's overall theory, but his work also includes selections from his English translation of Piaget's seminal three volume work *Introduction to Genetic Epistemology* (Introduction à l'èpistémologie génétique).

organic development. Hegel was working conceptually to present an a priori account of nature's development. Piaget, on the other hand, is working from empirical findings to uncover the underlying processes at work in biological development. Piaget is more concerned with the epistemological ramifications of development and assumes the correctness of evolutionary biology.

Piaget's stated goal, as expressed from the above quote, is to revive and provide a biological origin to human knowledge. He is trying to show how development unfolds and how it is the same regardless of whether it occurs in cognitive or biological systems. Piaget's investigation, the epistemological investigation of the biological development of knowledge, is only possible due to the availability of evolutionary theory, which was not available—in such completeness and degree—to Hegel.

Piaget's philosophy of nature is composed of the same logical principles as his theory of mind: assimilation, accommodation, equilibration, and decentration. Piaget is notably influenced by Kant. He claims that: "When a man or an animal perceives an object, he identifies it as belonging to certain categories, either conceptual or practical."[143] This conceptual categorization of experience is not only a Kantian assumption, but also directs Piaget's assertion that all knowledge is circular. If knowledge is experience categorized into conceptual structures, we can see how the Idea of Hegel, or logico-mathematical explanations of reality (metaphysical rationalization) for Piaget, comes to permeate all thoughts and objects of experience. Hidden also in this statement is Piaget's biological assumption. As an ethologist, Piaget argues that animals also assimilate reality to a certain degree, and are therefore conceptually categorizing experience (albeit to a lesser extent than human beings).

[143] Piaget, *Biology and Knowledge*, 5.

Piaget claims that: "Life is essentially autoregulation. The explanation of evolutionary mechanisms…seems set in the direction of a third solution, which is cybernetic and is, in effect, biased toward the theory of autoregulation."[144] For Piaget, the concepts guiding mental development also regulate and direct organic development. The crucial thing to remember regarding equilibration is that it is in response to exterior disturbances "whether experienced or anticipated."[145] This fact becomes centrally important with the development of higher level conceptualization and perceived disequilibria. For example, human beings can perceive the threat and result of the loss of honey bees from a region without having to physically experience the phenomena itself. This ability can allow for behavioral changes to offset perceived disequilibria, a useful capacity when considering the results of many environmentally degrading human practices. The conceptual experience of perceived disequilibria (that is, the abstract understanding of system interaction) in no way conflicts with Piaget's assertion that all equilibration is in response to exterior disturbances. I suggest that conceptual disequilibria are a form, however abstract, of experiential disequilibria. In alignment with Piaget's assumption that "all knowledge presupposes a physical structure," it holds that the root of all abstraction rests on phenomena.

Decentration is a changing concept for Piaget that becomes equated with equilibration in his later works. It could be considered a concept within equilibration itself. Where equilibration is defined as the autoregulative process that allows for stasis to emerge from dynamic flux, decentration is "…the developmental process of decentering from an originally centric point of

[144] Piaget, *Biology and Knowledge*, 26. The third solution is a reference to overcoming the problems that Piaget sees in Lamarckism and neo-Darwinism.
[145] Piaget, *Biology and Knowledge*, 12.

view."[146] This term, then, can come to mean all thought processes or actions—whether conscious or not—which are taken beyond a centric view. For Piaget, this concept is also applied to the social level regarding social development. Decentration serves the species rather than the individual. As Barbara Peterman claims:

> Decentration was increasingly not just a conscious, expressible worldview nor progressive differentiation of *structure* but a process operating below the level of consciousness to serve basic developmental *functions* as [Piaget] had conceived then from the beginning, most generally the adaptive functions of assimilation (matching the environment to the organisms structures) and accommodation (adjusting the organisms structures to fit the environment).[147]

I would elaborate on this idea, and claim that equilibration and decentration are the motivating forces of development for Piaget. Furthermore I suggest that they in fact show that he theorized an intentional force of development both in cognitive development but more importantly in organic development as well. Furthermore, because decentration advances outward in connectivity, it also advances development in terms of complexity. Autoregulation, through levels of equilibration, establishes greater and greater levels of complexity as well as interdependence. As disequilibria jars stasis into development, the affected object is thereby compelled to seek stasis in a new form. From this intrinsic imperative comes progression, the source of which is the constant flux of reality. This progression is necessarily more complex as smaller component systems come to develop into larger systems (either through their own expansion, or by absorbing other systems), culminating in one system encompassing all divergent systems within it.

Piaget sees the connection between physical/biological development and cognitive development as not only linked, but necessarily so. Furthermore, his theory works on two layers:

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[146] Peterman, *Origins of Piaget Concept of Decentration*, 1.
[147] Peterman, *Origins of Piaget Concept of Decentration*, 20. Brackets mine.

the diachronic and synchronic. The former deals with both collective and individual development over time. The latter deals with collective and individual systems of organization at specific moments in relation to disequilibria, equilibration, and reequilibration. Both cases respond to environmental influences jarring the organism's development. An example of the difference between diachronic and synchronic development can be provided by evolutionary anthropology. The evolutionary development of the family hominidae, both individually and collectively as a species, from the genus homo habilis to homo sapiens demonstrates diachronic development over time. The specific developmental achievement of homo habilis, both individually and collectively as genus, resulting in the use of primitive stone tools demonstrates an example of synchronic development. This suggests a fluidity of development between knowledge structures and the natural world. Nowhere else is this unity more clear for Piaget than in his treatment of the sciences.

As mentioned in the prior section, Piaget sees hypothetical deductive logical thinking as the pinnacle state of thought. The human sciences, therefore, share this conceptual commonality both with one another, as well as with a rationally structured world. For Piaget, logico-mathematical operations correspond to the world not because we learned them from the natural world, nor because we begin with an innate knowledge of them by which our perceptions are continually structured, but because our mutual and simultaneous development with the natural world makes it so. Piaget claims that human knowledge of the world came not from empiricism or sense experience (that is, the accommodation of schemata to objects), nor from *a priorism* (that is, the assimilation of objects to previously established conceptual schemata). Rather, knowledge is produced from the equilibrating efforts of both accommodation and assimilation to

make a correspondence between sensuous experience and our conceptual schematics.[148] Due to the biological foundation to knowledge suggested by Piaget, the rational structure shared between the mind and the world is developmentally necessary. It is by comprehending this fluidity between knowledge and natural development that Piaget is led to the aforementioned circle of the sciences.

There are clear links to be made here between Piaget and Hegel's theories of natural development. The first is that both set forth dialectical theories of development. These theories include both cognitive and organic development. What holds for both thinkers is the dialectical premise that as there is a logical progression along more and more complex lines which also maintains and permits movement through prior sublated forms of development. Furthermore, within their dialectical premise, they also claim that this dialectical development is logical and rational. Due to the fact that this development becomes increasingly more complex as it moves to higher and more complex stages of development, they also assert that development is not only historical, but that knowledge historically develops from the biological. Third, both thinkers posit that knowledge requires enactment, or action of some form, to be complete and materialize.[149] Finally, both set forth theories that show an intentional force in natural development. It has been shown that human self-knowledge, our knowledge of the natural world, and our technologies are the three main areas where we can see a shift in our thinking most clearly. The two former aspects of this conceptual shift have been addressed so far in the epistemological and natural theories of Hegel and Piaget. The later is the subject of the final chapter.

[148] Messerly, *Piaget's Concept of Evolution*, 69.
[149] Piaget, *Biology and Knowledge*, 6.

Both thinkers are elaborating the form of relationship that human beings have with their environment as being one of necessary symbiosis. Therefore, destruction of one part of the system cannot be displaced for long, and will eventually call irrational or systemically harmful practices into question. This is a naturally occurring form of equilibration between the environment and society. Here we can see the empirical necessity for biomimicry's development and occurance. However, if nature is treated as having a rational, and thereby conscious, intentional force—in the sense that it develops logically and in accordance to its own design, the logic of the world: Dialectics—then it cannot be solely considered a base object of experience. This realization is now coming to fuel an entirely new approach to knowledge, nature, and technology. This new realization is the rational thinking behind biomimicry and its approach to the natural world. It also marks a shift in human thinking and in rationality itself. We can see the results of this new approach to nature quite clearly in the technological development of biomimicry.

CHAPTER 5

CRITICAL THEORY, NATURE, AND A CHALLENGE TO ENLIGHTENMENT

The aim of science is to bring about this *slavery of nature*.[150]

Critical Theory is both a field of research and an interdisciplinary methodology. The focus of this chapter is to reconstruct the philosophical influences of critical theory. I give particular emphasis to its understanding of theory's relation to praxis and its related critique of so-called instrumental reason. This critique is in part a critique of domination. It suggests an important shift in focus from class conflict to our relationship to nature. Therefore, the first section begins with a look at these influences and shows how they have helped to direct these thinkers to the concept of nature. I begin by examining the Hegelian-Marxian roots of the tradition. Next I will look at the influence of psychoanalysis and the ways in which Critical Theory developed and absorbed it. The specific focus will be on Freudian psychoanalysis and the way the concept of nature began to shift for Critical Theory. Particular emphasis will be given to the concept of Eros.

The second section looks at critical theory itself, its project, and how it defines itself in relation to traditional theory. The final section addresses the critique of Enlightenment offered by the Frankfurt School. This critique not only defines instrumental rationality, but sets out a position against it. It is a theoretical response to the contradiction of rationality that has emerged from the modern project. This section deals with the new shift in thinking surrounding the enlightenment as well as a new regard for nature presented by both Max Horkheimer and Theodore Adorno in *Dialectic of Enlightenment* as well as Herbert Marcuse through his various works. I intend to argue that Critical Theory recognizes and makes explicit the epistemological

[150] Nietzsche, *Writings From the Late Notebooks*, 114.

shift taking place in the twentieth century. This shift is marked by a focus from the emancipation of the individual subject, to the recognition that emancipation of the subject must be cotemporaneous with the emancipation of nature (or at least its recognition by human beings as a conscious entity and our coexistence with it).

The Origins of Critical Theory: The Roots of Radicals

The common thread that unites critical theorists is the Hegelian premise that philosophy should be dialectical, critical, historical, and that theory is inherently linked to practice. Marx, as the intellectual progeny of Hegel, takes Hegel's concept of actualization and labor and makes it central to his theory. The emphasis of action and praxis with theory is the central guiding presupposition of Critical Theory. The concept of praxis is in essence the process by which theory manifests and turns itself into action in the world. It is in other words the enactment of theory. Martin Jay claims that: "Loosely defined, *praxis* was used to designate a kind of self creating action, which differed from the externally motivated behavior produced by forces outside man's control." Praxis deals specifically with theory and how human thought is enacted in the world rather that environmentally or physiologically determined action.[151] For the purpose of my discussion, technology will be considered as the defining human praxis. I take this position specifically because it is in a dialectical relationship to human knowledge and the natural world.

For Hegel, every truth that consciousness acquires emerges in actuality. This is consciousness' manifestation in the world. It is a form of labor in that consciousness is making the world in into its image and then reflecting on what is actualized in order to gain self-understanding. Any inconsistencies or contradictions emerging from the actualization of an idea

[151] Jay, *The Dialectical* Imagination, 4.

must be "worked" through and addressed before consciousness rests in completion and assurance. It is due to the individual's encounter and actualizing, or as Hegel says "negating" the world, that the individual is what it is and comes to know itself. This perpetual and reciprocating process of self-development though praxis is central to any discussion of Critical Theory. I have argued that biomimicry is a technology—a creation or actualization of human thought—that incorporates both a new self-understanding and relationship with nature. The explanation of this new technological development can be provided through a reading of Hegel, Marx, and the thinkers of the Frankfurt School.

Both Hegel and Marx suggest that social relations perpetually constitute individuals. This point in both thinkers is found in their conception of labour (Marx) and actualization (Hegel). Hegel claims that as the individual works and produces in the world, it assumes that the products of its labor are its own. This assumption quickly collapses when the product of individual labor enters into the social realm where it is subjected to (social) reason and the minds of others. As other consciousnesses reflect on the individual's product it then becomes a social endeavor. Therefore, by laboring in the world, the individual is contributing to the social and perpetuating the social, even if this is done inconsequently or unconsciously. Individuals working for themselves to fulfill their own desires soon come to see that the product of their labor simultaneously works for others and the social as well. Hegel calls this "being-for-another," and it manifests itself in the laws, institutions, and the customs of a society. Critical Theory will come to call this realization intersubjectivity. There are two forces at work in this theory. The first is the desire of the human being. That is, the nature of the human being. The second is the power of the individual to negate. This latter force is crucially important. It is this ability to negate that allows the individual to both create the conditions of its own existence, as well as to

self-negate and constrict the fulfillment of its own nature or desires. This self-negation is what Freud will later come to call repression, and views it as the prerequisite of civilization and social organization.

The material condition that man finds himself in is nature. Nature is the basis for life and all production. Production serves as means to reproduce life. We, human beings, are dependent on nature; or rather our life is contained within a circuit with nature. This statement still blurs the true relationship, which is simply that the human is inseparably nature. All labor is predicated on nature, as Marx claims: "The worker can create nothing without *nature*, without the *sensuous external world*. It is the material on which his labor is manifested, in which it is active, from which and by means of which it produces."[152] Material conditions are closely bound with labor, which Marx calls the mode of production, because it not only produces goods but the actual means for our continued existence. This dynamic will come into play with the invention of new technologies and resource competition. Technologies that are detrimental to recreating and reproducing the conditions of existence will come to be seen as contradictory. Furthermore, new technologies, such as biomimicry, and new relationships will develop that will seek to reconcile the contradictions that have emerged.

For both Marx and Hegel labor is not only a powerful tool for human beings to gain recognition and self-knowledge, it is necessary to that process. Marx argues that human beings as a species demarcate themselves from animal life when they are capable of controlling the production, through labor, of the means of their material existence. There emerges what Marx calls a "species-life," or the individual realizes its "species-being." The individual comes to see

[152] Marx, "Economic and Philosophic Manuscripts," 72.

himself or herself as a species, or rather as a member in a species.[153] This sounds very similar to Hegel's Spirit where a member of a society sees him or herself in the whole of society. This characteristic of species-being has specific qualities. One of the main qualities is conscious free creation (labor), which is very closely related to another quality of species-life: the production of the material conditions of existence. This is what Marx calls "conscious life-activity."[154] To be human means to have the conscious capacity to determine (in the Hegelian sense) nature in order to create the material conditions to continue human life. This is actualizing or laboring in the world.

The conception of the social in Hegel and Marx leads both thinkers to a unique theory of history. For Hegel history is the development of consciousness and reason, which culminates in the recognition of Sprit. History is therefore the process of the universe coming to know itself as it becomes consciously aware of itself. This process is fulfilled when "human being" comprehends the universality of reason and the Idea in all things and knows all things to be divisions or determinations of one universal Idea. Piaget would label this achievement decentration. For Marx, history is the development of the tension and the overcoming of class conflict and class struggle. More specifically, it is the development of the tension of the human being and its society both against itself and with nature. History, therefore, is the struggle of the human being for survival. This struggle can take the form of a struggle against other human beings for the means of production of life; or—what has been the case for all of human history—the struggle of human beings against the natural world. This struggle against nature is defined as the struggle for food, shelter, and against natural forces. Here Marx makes clear the

[153] See Marx, "Economic and Philosophic Manuscripts," 75 and "The German Ideology," 150.
[154] Marx, "Economic and Philosophic Manuscripts," 76.

influence of materialism on his conception of nature, suggesting that history is struggle in some material way.

One influence on Critical Theory, and the next to be presented here, that brings out this tension of the human/nature relationship is Freudian psychoanalysis. This shift to psychoanalysis opened up the theoretical doors through which Critical Theory's most powerful work could pass through. The influence of psychoanalysis on Critical Theory helped direct it to the issue of nature. This shift from class struggle to nature (and eventually to ecological concerns) reflects the major epistemological shift in the twentieth century. I claim that the shift in focus—from a primarily subject centered view of human emancipation to a view of emancipation incorporating the natural world—is the greatest epistemological shift in the modern period since the shift in formal subjective thinking which brought on the modern period to begin with. Therefore, Freudian psychoanalysis also played a formative role in the theoretical development of Critical Theory. Horkheimer read and was familiar with Freud prior to writing his essay "Traditional and Critical Theory." Jay argues in *The Dialectical Imagination* that Horkheimer's interest in Freud went back to the nineteen-twenties. His essay "Traditional and Critical Theory" was originally published in 1937.[155] It is safe then to say that a Freudian influence was present from the start of Critical Theory. In this essay, Horkheimer discusses the human relationship to nature. This is a crucial part of what will later drive the theoretical interests of Critical Theory. Horkheimer describes two forces that the individual struggles against. The first struggle is against the natural world itself. The second is against the restrictive or floundering social forces that fail to free up the individual and complete the human struggle against nature. Both can be considered an external struggle which in no way deals with internal nature. Regardless, the desire that is

[155] Jay, *The Dialectical Imagination*, 87.

directing this struggle and carrying it out is very much a product of the individual's or species intentionality and striving for continued existence.[156] The desire that Horkheimer is elucidating here is the desire for the mastery of nature and the unrestricted fulfillment of the individual's freedom from necessity. The "future condition" Horkheimer eludes to is the total domination of nature by instrumental rationality. By dominating and suppressing the other, human beings have attempted to unleash their freedom so they can will their desires without impedimenta. Before dealing with the question of nature's domination through instrumental rationality, let us first examine the source of this desire to dominate.

The influence of psychoanalysis is clearly present here. The desire to remove necessity from one's life and to be able to will freely one's desires is the central conflict discussed by psychoanalysis.[157] However, Hegel has something quite different to say about necessity and the human desire to overcome it. Necessity for Hegel shows self-consciousness its dependency. For Hegel, self-consciousness is defined by desire.[158] As the subject realizes the full potential of its ability to negate in the world, it experiences freedom and attempts to exert this new found freedom over the world for the completion of its desire. This project quickly encounters problems as the world of entities proves itself not only to be independent of the subject, but also the subject comes to the realization that it is dependent on the world. As the world asserts itself as independent of self-consciousness (and thereby displays to self-consciousness its dependence on the world), it also shows itself as *a* consciousness. This idea is an affront to the scientific understanding of the world as base phenomena rather than a flowing system of life.

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[156] Horkheimer, "Traditional and Critical Theory," 230. Brackets mine.
[157] Freud, *Civilization and Its Discontents*, 34-35. See also Freud's discussion of repression later on pages 51-52.
[158] Hegel, *Phenomenology of Spirit*, 105.

The failure of self-consciousness in overcoming necessity by asserting its freedom is not a question of superior tactics or technological deficiencies. This failure is the result of self-consciousness not coming to terms and comprehending that it is bound with nature for its existence and self-knowledge. According to Scott Jenkins, for Hegel there are two concepts of life. The first concept deals with individual and collective organisms. This group is both ontogenic and phylogenic. The second concept deals with a general concept of life as self-determination.[159] The only way for the subject to move forward successfully is through self-negation.[160] This leads the subject to see that it is therefore dependent upon nature. This seemingly counterintuitive self-limiting of freedom brings to consciousness the realization that it is in an interconnected relationship with the natural world and furthermore that our fate is tied to mutual survival. Such a realization is not an easy pill for human beings to swallow because it directly confronts and delimits human freedom. Human freedom—that is the ability to determine and negate in the world, in either praxis or through thought—is the defining characteristic of the human being. The natural world assaulting this characteristic by exposing human dependency is a direct assault to the human being itself (or at least to its freedom). Human beings have great difficulty in reconciling this duplicitous (and somewhat dysfunctional) relationship with an incommunicable natural world. What Hegel suggests is that rather than see self-conscious (subjective) reason as constituting the world thereby making the subject master of the world and the world subject to its desires, we instead see both ourselves, and the world, as constituted by reason in a flowing system of life. Despite Hegel's insight, human beings still struggle to dominate nature and bend it to their will.

[159] Jenkins, "Hegel's Concept of Desire," 109.
[160] Hegel, *Phenomenology of Spirit*, 109.

There are three ways in which human beings struggle against the natural world. The first is the struggle for physical existence. This struggle is the simple ability to exist in the world. It includes shelter, protection from natural phenomena (such as natural disasters or exposure), and the ability to locate what Hegel calls the Conditions of Existence. A practical example would be the struggle of locating wild fruit in nature and utilizing it as a seasonal food source. The second struggle is for the means to reproduce life through the control of the Conditions of Existence. This is the defining Marxian struggle where humans must confront the natural world, and work it over, to attain the means of reproducing life, specifically species-life. As we can see with Marx, the human beings' desire to control and master the means for reproducing life is the bifurcating element dividing humans from the natural world. Control of the conditions of existence is a source of conflict between human beings and nature, as well as against other nations, societies, and classes of people. A practical example of this struggle would be human beings rationally organizing fields of fruit crops as a continual source of sustenance. Finally, there is the struggle to assert human freedom over the world. This struggle is defined by the human control not only of the conditions of existence, but by our directing their development in accordance with human desires. A practical example of such an attempt to bend nature to human desires would be the rational engineering of fruit crops for higher yield, pest and drought resistance, or seedlessness. As human beings attempt to master the natural world, nature itself shows them that they are not independent from it. Rather, their freedom is determined by nature itself.

To begin with, the human being appears, and for all intents and purposes is, naked and alone in the world in regard to nature. The terror and uncertainty that human beings felt at being at the mercy of the natural world would not be soon forgotten. Indeed, this fear and uncertainty in the face of nature still dwells in the psychic mind of the human being and works—at some

level—to both direct their actions and influence their treatment of nature. The struggle against the forces of nature for security and sustenance has historically been, and continues to be, the human condition *par excellence*. The illusory myth of a Garden of Eden where humans lived in harmony with the natural world is a complete falsehood. However, this myth serves a central purpose in the narrative of domination. The use of myth, contrary to the arguments of its proponents, is heavily utilized by enlightenment thought. According to William Leiss, Francis Bacon was the central figure advocating for a dominant position of man over the natural world. Bacon based his myth for domination of nature in Christian doctrine. He not only elaborated on the Christian doctrine that human beings should be the masters of the natural world, but also secularized it so that it could be taken up by enlightenment thought.[161] The use of myth was central to establishing the founding doctrines of enlightenment thought.

Society, its institutions, and human history (in all of its achievements and shortcomings) are defined by the human struggle against nature. I maintain that the feeling of uncertainty and inferiority that nature cultivates in the human mind serves to perpetuate and justify this desire for mastery and control. Next, there is a direct attack by nature on human will or freedom. In absolutely every case where human beings attempt to assert their freedom from the necessity of natural life, nature quickly reminds them of their dependence on it. The psychological implications of these combined desires and repressions are the direct influences that have perpetuated the modern epistemology. Or rather this epistemology, grounded on the desire for mastering nature, has been at work for all of human history. The Enlightenment simply cultivated, articulated, perpetuated, and most importantly advanced (by means of systematic technological control), this epistemology.

[161] Leiss, *The Domination of Nature*," 49.

Concerning the desire to dominate nature, Leiss claims that, "…for the Frankfurt School theorists, the drive to dominate the rest of nature has been a feature of all human development to date and the primary characteristic of the faculty of reason."[162] Thinkers in this tradition maintain that the drive to dominate nature is a defining human characteristic present in all of history. Where did this idea so foundational to the Frankfurt School originate? It is a direct result of their absorption of Freudian psychoanalysis. Freud adds a deeper layer to the struggle for human freedom over nature by questioning the basic assumption that human beings are separate from nature. He suggests that human nature itself is also controlled, mastered, or repressed. He claims that the struggle against nature is, "…what all life essentially consists of, and the evolution of civilization may therefore be simply described as the struggle for life of the human species."[163] Here the shift occurs from the mastery of the external world to the mastery of the internal world of the individual subject. This is a defining feature of human civilization. The basic conflict Freud elaborates is that civilization is necessary for the survival of the human species, but it will always cause discomfort or suffering for the individual. This happens for two reasons. First, this is because the individual is less important than the species. Secondly, this is because the freedom and fulfillment of individual desires is restrained by civilization.[164] It is this collapse of the domination of nature to include both external nature and internal human nature that Critical Theory takes up.[165]

Human beings, as part of the natural world, are likewise subject to the repression and control that they exert on external nature. Such mastery, control, and repression of external nature are simultaneously the human repression of itself and its own nature. Unlike Hegel—who

[162] Leiss, "The Problem of Man and Nature in the Work of the Frankfurt School," 164.
[163] Freud, *Civilization and Its Discontents*, 82.
[164] Freud, *Civilization and Its Discontents*, see specifically: 14-15, and 48-49.
[165] Leiss, "Technological Rationality," 35.

finds freedom in the recognition that the individual is part of a whole (society or civilization) and identifies itself with that whole—Freud suggests that there is a constant battle, between the desires of the individual and the repressive forces of civilization, which function to stifle human freedom thereby creating psychic unhealth or neurosis. Freud uses the German word *Trieb* meaning drive or urges. This is also the term that Hegel uses when describing desire. As Andrew Fiala claims, while arguing against Hegel's use of metaphors: "In speaking of orgainic development, Hegel indicates that the movement from implicitly to explicit is an impulse or desire (Trieb)…Development is understood in terms of a force that impels if forward by the mechanism of desire."[166] Hegel sees the desire or drive at work in all development as a motivational force. Just as Hegel describes the seed as being compelled toward developing its potential, so too are ideas and concepts compelled toward completion.

Desire is one link that these thinkers share in regard to formulating needs-based theories. As Jonathan Lear points out, drive has a unique meaning for Freud.

> An *Instinkt*, for Freud, is a rigid, innate behavior patter, characteristic of animal behavior…A *Trieb*, by contrast, has a certain plasticity: its aim and direction is to some extent shaped by experience…Drives are a continuous source of pressure within human life. And this pressure has a distinctively psychological aspect…Since it is a psychical representation of biological stimuli, its meaning is given by the mental representation which partially constitutes it. Drives are the simplest constituents of the mind.[167]

This statement holds several key aspects to understanding the role of drives for Freud. Drives are not only a motivational force impelling behavior, but they are also determined by experience. There is also a connection to be made here between the biological forces at work in the

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[166] Fiala, "The Dawning of Desire," 56-57.

[167] Lear, *Love and Its Place in Nature*, 123-124. See also Mills, "Clarification on *Trieb*," 674. "*Instinkt* was a word Freud rarely used in the context of the human subject, which he reserved for animal species, and loathed it for its simple equation to material reduction: this is precisely why he deliberately chose the word *Trieb*—more appropriately translated as drive, impulse, or urge—to characterize human motivation."

formation of drives. Jon Mills argues that the source of drives is biological for Freud, whereas the motives of drives "…are complex phenomena subject to many intervening and emergent interactive effects both internally mediated and externally influenced."[168] This claim calls into question any distinct division of the mind or psyche from its physical biological form. Here we can see the seeds of the incarnate mind and the biological origins of human knowledge that will be argued for by later thinkers such as Merleau-Ponty and Piaget. The ideas defining the concept of *Trieb* for Freud can also be seen in the thought of Hegel and Piaget. Such ideas as a developmental impulse at work in development, the formative role of experience in this development and the construction of developmental forces, the unification of the mind and body, as well the argument that knowledge is biologically grounded. Freud sees the desires at work on the individual as twofold. These two forces at work in human desire are Eros—the impulse towards life and (pro)creation—and Thantanos—the impulse to aggression and destruction.

According to Freud, it is in the interplay of these two forces at work on the individual that psychic life is produced. Mills states: "[Freud] concludes that mind is an architectonic, epigenetic achievement that evolves from the most rudimentary expression of the dialectic of life and death—hence from the libidinal activity of Eros to the destructive will of [the death drive]."[169] Eros can be considered for the time being as the main intentional force at work in nature, which all theorists are attempting to elucidate. Lear argues that Eros constitutes more than just a libidinal force and serves to encompass sexual love and union as well as self-love, parental or familial love, and a general love for humanity.[170] In any of these forms, Eros is still regarded as the productive and creative impulse. Both impulses will play a central role in all the

[168] Mills, "Clarification on *Trieb*," 675.
[169] Mills, "Clarification on *Trieb*," 677. Brackets mine.
[170] Lear, *Love and Its Place in Nature*, 140.

theorists being discussed. Eros is also centrally important to my latter discussion of biomimicry and the role of technology in the formation of self-knowledge. The key point to remember is that these forces work on both a psychic and biological level. I will now shift my focus from Freud's influence on Critical Theory to how Critical Theory applies Freud's theory to reevaluate the modern concept of nature.

Defining Critical Theory and the Shift to Nature

Horkheimer's essay "Traditional and Critical Theory," is foundational in that it sets out the particular research program of Critical Theory and also establishes a new theme for critical research: The struggle against, and mastery of, nature. Before discussing what Horkheimer offers that is new and radical to Traditional Theory, we must first look at how Traditional Theory is defined. Traditional Theory for Horkheimer is definable as universal, systematic, and abstract. He claims:

> The general goal of all theory is a universal systematic science, not limited to any particular subject matter but embracing all possible objects…The same conceptual apparatus which was elaborated for the analysis of inanimate nature is serving to classify animate nature as well, and anyone who has mastered the use of it, that is, the rules for derivation, the symbols, the process of comparing derived propositions with observable fact, can use it at any time.[171]

Here the specific function of the conceptual apparatus Horkheimer is referring to is analysis, or the systematic breaking apart of all knowledge or reality into its component features. This form of understanding is a distinctional understanding rather than a relational one. It is abstract, in that the form of thought (conceptualization) is separated from the content, whether it is reality, experience, or thought itself. Scientific analysis creates facts that appear as neutral and objective. Objectivity is supported by the claim of universalization, which suggests that anyone working within the framework of its theory is able to reproduce the results (either empirically or

[171] Horkheimer, "Traditional and Critical Theory," 189.

theoretically) and thereby effectively add strength to the argument for the objectivity of the formalized abstract system. However, even the desire to seek out facts and the process for formulating them comes with certain assumptions. The explanation and critique of Traditional Theory that Horkheimer gives is similar to the critique that Hegel gives to Kant regarding his definition of the Understanding in the *Phenomenology of Spirit*.[172]

This abstraction from content—along with the symbolic construction of the rules of analytical logic, which can be systematically applied and superimposed onto any content, making it "universal"—is the argument for Traditional Theory's universality; simply because "anyone who has mastered the use of it…can use it at any time." It is through the analysis of the premises of Traditional Theory itself that we are able to clearly see the assumptions that drive the analytical or natural sciences: The claim to universality; to objectivity; the claim that it is ahistorical and asocial; that both animate and inanimate nature is base, lifeless, and without essence; and finally that thought or human beings are somehow separate and independent from the sensuous external world. This is the aftermath of Cartesianism, and the highest theoretical achievement of the human desire to master nature.[173]

Horkheimer sees this mastery as necessary for so long as human beings exist, so too will the urge to dominate nature. He claims: "The continuous progress of a truth that is independent of the thinking subject or a trust in the advance of science can refer in the proper and strict sense only to that function of knowledge which will continue to be necessary even in a future society, namely the mastering of nature."[174] The working over of nature to secure the means of species survival will always be a part of the human experience. Regardless, the degree to which nature is

[172] Hegel, *Phenomenology of Spirit*, 46.
[173] Horkheimer, "Traditional and Critical Theory," 231.
[174] Horkheimer, "Traditional and Critical Theory," 240.

dominated and made subservient to human will is not a fixed matter. With this argument, Horkheimer is both brings this relationship of domination to a conscious level as well as hinting at a sublation of this mastery into a relationship of emancipation. What Horkheimer is advocating is not only our awareness of it, but a sublation of this mastery into a relationship of emancipation. He states: "For the kind of thinking that simply registers facts there are always only series of phenomena, never forces and counterforces; but this, of course, says something about this kind of thinking, not about nature."[175] Here we can see Horkheimer's position. He is suggesting that science and Traditional Theory must have first approached the world in such a way as to deduce the base form of nature as phenomena in order to achieve their beloved claim to objectivity, which they desperately claw onto.

This view of nature is beginning to change on two fronts. It is altering due to pressures coming from opposing forces that wish to see a more equal and emancipated relationship with nature. Finally, and most importantly it is altering due to internal pressures within the findings of the natural sciences. As Trent Schroyer claims:

> One by one the metaphysical implications of modern science—such as the dualisms of body and mind, nature and God, empiricism and rationalism—have been exposed to critical clarification and traced to the seventeenth-century exclusion of mind from nature. Similarly, the reductionist imperative of modern science is now being challenged by conjectures that natural unities, or complex wholes, cannot be reduced to fundamental composite units.[176]

We can see here the beginning of a shift in the natural sciences away from theories which treat phenomena as individuated components independent of any whole or unity. The natural sciences which have grounded themselves on the individuation and division are shifting, by their own

[175] Horkheimer, "Traditional and Critical Theory," 229.
[176] Schroyer, "Critique of the Instrumental Interest in Nature," 159-160.

investigative insights and discoveries, into a whole systems thinking capable of collapsing the differences they have previously established.

Critical Theory, in contrast, takes a different approach to the "discovery" of facts and theory. It suggests that all theory is social, historical, and has a relationship to nature. Horkheimer also claims that all theory is an ideological category which is produced out of human conditions.[177] In other words, science and theory are not independent of society. Horkheimer suggests that, "…the self knowledge of everyday man is not a mathematical knowledge of nature which claims to be the eternal Logos, but a critical theory of society as it is, a theory dominated at every turn by a concern for reasonable conditions of life."[178] What Critical Theory is refusing to accept here is the possibility that a mathematical form of logic can exhaust human knowledge, and that form can be entirely separated from content. The objectivity that science asserts is not a universal objectivity, but rather a byproduct of that theory's accepted ideology and society's accepted epistemology.

It is through this critique of Traditional Theory that Critical Theory shows its own assumptions. Firstly, it does not claim objectivity and neutrality. In fact it suggests that not only are these things unattainable but any theory that does make claims to them is ideological and dominating. Secondly, theory is tied to emancipation and the fulfillment of human freedom. Thirdly, it deals with the actual conditions of life. In other words, it is social and historical. Finally, it deals with the relationship of human beings to their natural environment. This final relationship is defined as man's struggle with nature. Horkheimer claims: "There will always be something that is extrinsic to man's intellectual and material activity, namely nature as the

[177] Horkheimer, "Traditional and Critical Theory," 194.
[178] Horkheimer, "Traditional and Critical Theory," 199.

totality of as yet unmastered elements with which society must deal."[179] The other question that emerges—and may possibly be a source of the pessimism of the Dialectic of Enlightenment—is what happens when the "as yet unmastered elements" are mastered. Here rests the fear that the 'Other' which is nature can become totally dominated and suppressed by instrumental reason.

In fact, Horkheimer, in good Hegelian and dialectical fashion, claims that Critical Theory is the result of tension. "The identification, then, of men of critical mind with their society is marked by tension, and the tension characterizes all the concepts of the critical way of thinking."[180] It is tension then that provokes the critical thought. Innovation, discovery, or progress is not possible based on the development of "sheer logic alone."[181] What is needed is the critical moment, the dialectical moment, where tension and conflict birth the new. The other important point which Horkheimer is placing his finger on is the tension in the human relationship with the natural world. This concern becomes more expressed and elaborated later in the tradition's history and through the development of its thought.

Instrumental Reason and the Challenge to Enlightenment

If one looks closely enough, there already appears the trajectory of the argument made by Critical Theory on the domination of nature and the Enlightenment myth within Hegel, Marx and Freud. What Critical Theory does is make this argument explicit. The central work which deals with this question and of Critical Theory in general, is Horkheimer and Adorno's *Dialectic of Enlightenment*. This book is not prescriptive in any way; its true power is as a work of criticism. As was detailed in the prior section, I suggest that the history of epistemology is marked by the human being's urge to dominate nature and control the natural forces of the world. This

[179] Horkheimer, "Traditional and Critical Theory," 210.
[180] Horkheimer, "Traditional and Critical Theory," 208.
[181] Horkheimer, "Traditional and Critical Theory," 195.

epistemology of domination shifted into crisis during the twentieth century. This shift is what Horkheimer and Adorno examine and focus on. So what was the crisis that provoked a shift in this epistemic framework? It is true as Horkheimer and Adorno suggest that the Holocaust made this crisis explicit. However, the roots of this crisis go back much further.

The Holocaust showed the industrial scale of instrumental rationality in a way that had never before been seen. It was not the Holocaust as a distorted logical extension of the industrial process. Nor was it the industrial revolution as the logical fulfillment of instrumental rationality. Rather, all these developments are the logical result of the human urge to control and master nature going back to the earliest moments of human history.[182] It was only at this point, with instrumental rationality pushed to such a logical extreme and the unrestricted forces of domination and control fully unleashed on the human being itself, that Horkheimer and Adorno were able to look back and critique this epistemology. With their critique comes a challenge to Enlightenment: If the tenets of rationality work to subdue nature and in the process are actually destroying it (and human beings by extension), what good is rationality if it does not both serve and preserve life?

Max Weber recognizes enlightenment in its true form, not as the freedom of human beings from self imposed ignorance, but as the disenchantment of the world and its reduction to base matter.[183] Horkheimer and Adorno also recognize this new shift which makes explicit the

[182] Freud, *Civilization and Its Discontents*, 112. Freud claims that: "Men have gained control over the forces of nature to such an extent that with their help they would have no difficulty in exterminating one another to the last man." Here Freud rightly makes this connection to show us how war and genocide on an industrial level is a logical outcome of the human desire to master nature.

[183] Weber, "Science as a Vocation," 139. The reference to human beings self-imposed ignorance is to Kant's essay "What is Enlightenment." A connection can also be made to Heidegger here as well. By treating nature as base matter we open up the possibility of technological instrumental

epistemological stance of the human beings' desire to master *Nature*. "In thought," they claim "human beings distance themselves from nature in order to arrange it in such a way that it can be mastered."[184] However, rather than embracing this program and exalting its successes, they argue instead that, "Enlightenment, understood in the widest sense as the advance of thought, has always aimed at liberating human beings from fear and installing them as masters. Yet the wholly enlightened earth is radiant with triumphant calamity. Enlightenment's program was the disenchantment of the world."[185] Here the epistemological shift begins to make itself present. It is at this historical point that the unbroken faith in the enlightenment program comes into question in the face of the monstrosities carried out in the name of enlightenment and reason. It is only after we come face to face with this purely negative moment that we can open up the possibility of thinking it in any new way.

The disenchantment of the world would not have been possible if not for instrumental rationality. Instrumental rationality is the attempt to reduce the world to calculable entities that serve human utility and subsequently extract all content from the world. This reduction of the world to base calculable entities provides instrumental rationality with the universality it was desperately seeking. Hand in hand with this epistemology comes formal logic, which "…offered Enlightenment thinkers a schema for making the world calculable."[186] With universality,

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rationality to use the natural world unimpeded as a "standing reserve." Heidegger, *Question Concerning Technology*, 32.

[184] Horkheimer & Adorno, *Dialectic of Enlightenment*, 31.

[185] Horkheimer & Adorno, *Dialectic of Enlightenment*, 1.

[186] Horkheimer & Adorno, *Dialectic of Enlightenment*, 64. They claim: "Thinking, as understood by the Enlightenment, is the process of establishing a unified, scientific order and of deriving factual knowledge from principles, whether these principles are interpreted as arbitrarily posited axioms, innate ideas, or the highest abstractions. The laws of logic establish the most universal relationships within the order and define them. Unity lies in self-consistency. The principle of contradiction is the system *in nuce*. Knowledge consists in subsumption under principles. It is one with judgment, by which perceptions are incorporated into the system." Here we can see the

calculability, and formal logic, instrumental rationality was set on its path. For Horkheimer and Adorno—as well as for Hegel—this form of rationality is incomplete. Enlightenment thought fails to accomplish the self negation that Hegel suggests self-consciousness must do in the face of nature. Or in Horkheimer and Adorno's words: "The superiority of nature in the competitive struggle is repeatedly confirmed by the very mind which has mastered nature."[187] Forgoing this recognition requires the human being to trick and beguile nature to continually meet its ends and fulfill its desires. This subterfuge takes the form of technological advancements and manipulations of nature. In other words, the enlightened mind adheres to nature as much as is necessary, in a rational and calculating way, to rationally fulfill its desires.

It seems that self-preservation is the motivating force behind to the human desire to master nature, as well as to the development of instrumental rationality to accomplish this mastery. I suggest this connection also shows the extent of the enlightenment project, which can trace its origins to the earliest human attempts to rationally organize a field of crops or work over a natural material to fulfill a human utility. Leiss claims that: "For the Frankfurt theorists, the drive to dominate the rest of nature has been a feature of all human development to date and the primary characteristic of the faculty of reason."[188] This connection to self-preservation, and the desire of human beings to control their means of survival, is intimately linked to the human urge to dominate nature. It is a transgenerationally learned and transmitted relationship.

However, as Horkheimer and Adorno argue, the mere fact that self-preservation is contrasted with species destruction shows the futility of arranging such a binary opposition when

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importance of both the law of identity and the law of non-contradiction to the service and development of instrumental reason.

[187] Horkheimer & Adorno, *Dialectic of Enlightenment*, 44.

[188] Leiss, "The Problem of Man and Nature," 164.

not only are human beings dependent on the natural world, but both are in fact compose one reality in a fluid and dynamic relationship with itself. They claim:

> The exclusivity of logical laws stems from this obdurate adherence to function and ultimately from the compulsive character of self-preservation. The latter is constantly magnified into the choice between survival and doom, a choice which is reflected even in the principle that, of two contradictory propositions, only one can be true and the other false.[189]

Here Horkheimer and Adorno draw a fascinating link between the desire for self-preservation and the development and success of the law of non-contradiction. When reducing choices of self-preservation to the binary opposition of either *I live or entity "x" must either die or go extinct*, the assurance of the law on non-contradiction provides security and assurance by simplifying the decision. However the question remains: Is this a successful worldview in the long term when recognizing the truth of the interconnectedness of the natural world? Rather than pose the choice as one of human survival or the mastery of the natural world, Horkheimer and Adorno are suggesting that posing the question this way excludes the possibility of a sustainable or codependent relationship.

As insightful as it is, we cannot simply continue Horkheimer and Adorno's critique. It leaves us with criticism but little guidance. I claim that the emancipatory potential of biomimicry and the thinking around closed loop sustainable systems allows us to glimpse the future as well as our path out of a dominating mindset. If there is a characteristic of human beings, it is that we have never been able to settle with the limits presented to us. This inability to be satiated is both a blessing and a curse. In some cases it creates devastating problems. A case in point would be constructing an entire global economic and transportation infrastructure on a finite resource. However, this trait is also what will not let us rest on such advances. Thought which moves

[189] Horkheimer & Adorno, *Dialectic of Enlightenment*, 23.

toward sustainability does not entail stagnation. In other words, sustainable thinking does not require limits to progress, but rather a rethinking of not only what constitutes progress but also what its end-goal should be. Progress continues as it always and necessarily will do. It is the direction which is at issue. Many argue that science is a perfect methodology for promoting and cultivating change. Marcuse in "The Responsibility of Science," references a passage from C. P. Snow who claims: "Science is a self-correcting system."[190] This claim is meant to suggest that any errors that science commits will be corrected for through its own process of investigation. It is true that science is self-monitoring. However, the more structural the errors in investigation and practices are, the longer and more devastating they become until their correction. For our purposes, the treatment of nature as a base matter to be utilized for human ends, or for the domination of nature by human beings, are both structural presuppositions with damaging results.

The debate is not over *if* we will change, but whether this change will be an advance and progression, or a backwards-moving reversion. Movement is fated. Any attempt at a neo-luddite return to an imagined harmony with nature is futile. As Leiss claims, critical theory is seeking, "…a relationship which builds upon the positive features of this development (that is, the "rational mastery of nature" that is definitive of the modern period), rather than rejecting it in the name of an illusory 'return to nature.'"[191] Institutions, technologies, and practices necessarily alter. The impulses against change—the desire to find something that works and stick to it—is also the same impulse that drives thinkers dogmatically toward stasis and away from dialectical thought.

[190] Marcuse, "The Responsibility of Science," 478.
[191] Leiss, "The Problem of Man and Nature," 164. Parentheses mine.

So what then are the alternatives to instrumental rationality; and if human beings are so deeply committed to this form of reason, is an alternative even possible? Herbert Marcuse suggests that there must be an alternative; furthermore, this alternative does not necessarily exclude instrumental rationality but instead sublates it. A higher form of science and technology will be formed that contains instrumental rationality within it yet is not defined exclusively by it. Just as Hegel, as we will see, sublates formal logic into a dialectical logic, so too does Critical Theory suggest that instrumental reason will always necessarily be represented even as it is sublated into a higher form.[192] Marcuse claims that we must move forward and that doing so requires developing a new science, and a new technology that builds from instrumental reason, as well as carries it along into this new form of reason. He does not make explicit what this new rationality will look like. However, he claims that its emergence is linked to the emancipation of both nature and humanity.

Marcuse claims that a change in the concept of nature subsequently affects society. Consistent with psychoanalysis, Marcuse also considers both external and internal (or human) nature. In a move that shows Critical Theory's adherence to its historical presuppositions, Marcuse states:

> Nature is a part of history, an object of history; therefore, "liberation of nature" cannot mean returning to a pre-technological stage, but advancing to the use of the achievements of technological civilization for freeing man and nature from the destructive abuse of science and technology in the service of exploitation.[193]

[192] Leiss, "The Problem of Man and Nature," 167. Leiss claims that: "Human reason inevitably brings to bear its historically conditioned perspectives on 'nature,' and necessarily the 'instrumental perspective' will *always* be represented in some form." He is suggesting here that not only is the concept of Nature historically created and altered, but humans require instrumental reason for any sort of existence in relation to Nature.
[193] Marcuse, *Counter Revolution and Revolt*, 60.

This notion that change must necessarily occur is an important idea that many naïve environmentalist fail to understand. Leiss also echos this idea, that we have to progress and move beyond naïve environmentalism if a real emancipation of human beings and nature is to occur. Leiss calls for, "…a relationship which builds upon the positive features of this development [that is, the development achieved by modern science], rather than rejecting it in the name of an illusory 'return to nature.'"[194]

Marcuse offers nothing in the way of what such a science, technology, or society would look like apart from suggesting that the natural world and human beings will no longer be treated as a mere utility, and will be free from the exploitative qualities of capitalism and instrumental reason. I suggest, after a long journey through Hegel and the development of consciousness, that biomimicry represents this nascent emergence of the new technology—perhaps not completely free from exploitation, but certainly premised on a radically different concept of nature—that Marcuse is attempting to articulate. I also claim that the emergence of such a science and technology is the fulfillment of, and can be justified by, Hegel's *Philosophy of Nature*.

In summary, I have recounted the origins and foundations of critical theory in the work of Hegel, Marx, and Freud. From out of these origins we were able to observe the shifting focus of critical theory and how it came to take up the problem of enlightenment thought and the human relationship to nature. Unfortunately only a portion of this critique was able to be presented through the thought of Horkheimer, Adorno, and Marcuse. By examining this critique of rationality, we are able to see how the emergence of biomimicry is philosophically directed. Just as philosophy details the limits of knowledge and the scope of the problems facing human beings, there are similarly attempts as correcting these problems and limits through praxis. The

[194] Leiss, "The Problem of Man and Nature in the Work of the Frankfurt School," 164.

new science and new technology that Marcuse heralded was not utopian hopefulness as many claim, but the beckoning on of a new age being brought forth in this moment through the technology of biomimicry.

The philosophical roots of this technology reside with Hegel and Piaget. Hegel presented a unified theory of the dialectical development of mind thought the natural world culminating with the human being as spirit. His theory states that there can be no outside or other to mind, and any attempt to posit an other will only be met with contradiction and eventual revolution. Marx and the theorists of the Frankfurt School took up this theoretical approach to nature and development and therefore share a commonality with Hegel. Piaget also took up this idea of dialectical development and expanded on it. His theory shows how the dialectic plays itself out empirically, as well as how all knowledge is interconnected. This unification is the result of a common dialectical process of development. All the thinkers mentioned are pointing to a new way of thinking of knowledge and nature that, I suggest, is becoming clearer by the development of biomimetic technology.

PRÉCIS

This project is an attempt to outline a theoretical framework, drawing from existing theories, which I claim is not only a more correct way to engage with reality—as well as a regulative ideal by which to direct technological development—but also serves to explain our praxis as it relates to the world in both an emancipatory and sustainable way. I claimed that biomimicry is a new technology that is developed by and affects both our self-understanding and relationship to the natural world. Furthermore, this shift in the human worldview has occurred for two reasons. First, because as a species we have come to experience a contradiction of resources and environmental degradation, and secondly because there is a contradiction in our rational understanding of the world.

The only sense in which life on this planet is singularly exceptional is that it is uniquely specific to this planet. For that reason alone every aspect of it should be of the greatest value and interest to us. The notion that we have the solutions to our environmental challenges all around us in the natural systems of the earth is the central premise of biomimicry. In this sense, nature can appear before us as a conscious entity capable of giving rational solutions. In our insatiable blitz for control, certainty, and security we have gone against the rationality of nature which is cyclical, dialectical, and builds structures not so much to be eternal (in the human sense predicated on an irrational fear of death), but to encourage continuity and the persistence of process. Nature's greatest strength is that it is radically indiscriminate. Counterpoised, the human mind seeks identity and discriminates to the highest degree. This is how we have ended up in discord with the natural world and in a hostile relationship to it.

The relevance for such a study is, I hope, not lost on any critically minded individual. Rather than coming to terms with nature and the natural limits that human beings must abide by,

we either repress it in the name of progress or revert to its base forms uncritically. Despite this, torrential times are definitive of both humanity and its history. Only now, with the world all but entirely "enlightened" and demystified, are we capable of seeing the true force (and results) of our struggle for survival.

This struggle demands that we perpetually "other" all that we essentially are as part of nature. Similarly, looking to an "other," as either the cause of the detriment, or as an attempt to misplace accountability, eschews the true purpose and prodigious duty that is the human experience. Basking in the glow of cynicism and apathy is also to renounce the destination given to us by the world. This is not an option that human beings can afford to embrace. It is not a unified synthesis of the overcoming of contradiction, but rather the sad reality of dissimulation which hides itself in uncaring. Such a form of dealing with contradiction is problematic on many levels and cannot be maintained. Contradictions will emerge and continue until expressly recognized or reacted to.

The idea, which countless thinkers through countless words have tried to purvey to all of humanity, is that our responsibility to the world is linked directly to our freedom. This truism holds, along with the converse—that visionary truth that calls to every human being in every age, through whose guidance humanity has become what it is independent of the values designated to our actions, and by its recognition in the hearts of all holds the seed of salvation and thereby the future—that with our freedom comes responsibility. It is from this realization that we are torn in two and burdened with the knowledge that as we battle against ourselves—nature being part of us—the death of either births no victor.

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